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Evaluation of Motor Vehicle Emissions Inspection and Maintenance Programs in Ohio. Phase III

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Recent data for the State of Ohio indicates that the National Ambient Air Quality Standards for CO and O_x will not be attained in all areas of the state by 1982, even if all reasonably available control technologies are applied. In view of this, it is likely that the state will request from U.S. EPA an extension of the compliance date beyond 1982. In order for this request to be considered, the state must, among other things, have adopted a firm schedule for implementing a motor vehicle inspection and maintenance (I/M) program in the highly urbanized nonattainment areas. In this connection, the State of Ohio is currently planning for the implementation of an I/M program. As part of this effort, detailed analyses have been performed of the costs, benefits, personnel requirements, direct and indirect impacts, and scheduling requirements associated with the particular program option being considered. This document reports these analyses.

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EVALUATION OF MOTOR VEHICLE EMISSIONS INSPECTION AND MAINTENANCE PROGRAMS IN OHIO

PHASE 3

Final Report

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This Final Report was furnished to the Environmental Protection Agency by GCA Corporation, GCA/Technology Division, Burlington Road, Bedford, Massachusetts 01730, in fulfillment of Contract No. 68-02-2887, Work Assignment No. 5. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency. Mention of company or product names is not to be considered as an endorsement by the Environmental Protection Agency.

ABSTRACT

Recent data for the State of Ohio indicate that the National Ambient Air Quality Standards for CO and O_x will not be attained in all areas of the state by 1982, even if all reasonably available control technologies are applied. In view of this, it is likely that the state will request from U.S. EPA an extension of the compliance data beyond 1982. In order for this request to be considered, the state must, among other things, have adopted a firm schedule for implementing a motor vehicle inspection and maintenance (I/M) program in the highly urbanized nonattainment areas. In this connection, the State of Ohio is currently planning for the implementation of an I/M program. As part of this effort, detailed analyses have been performed of the costs, benefits, personnel requirements, direct and indirect impacts, and scheduling requirements associated with the particular program option being considered. This document reports these analyses.

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SECTION 1

EXECUTIVE SUMMARY

INTRODUCTION

Need for Inspection/Maintenance Programs

Recent ambient air quality data for the State of Ohio indicate widespread and frequent violations of the National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO) and photochemical oxidants (O_x). These national standards have been established in order to protect the public health and welfare. Both CO and O_x are gases which in sufficient concentrations in the atmosphere are potentially harmful to the public health. A major source of CO and O_x in Ohio is its motor vehicle population. Carbon monoxide is directly produced by gasoline-burning internal combustion engines, and photochemical oxidants are indirect products, formed through a complex series of atmospheric reactions in which two other direct products of combustion, unburned gaseous hydrocarbons (HC) and oxides of nitrogen (NO_x), combine in the presence of sunlight. An Inspection/maintenance program is a cost-effective strategy to reduce these pollutant emissions from motor vehicles. Other strategies that have been suggested, such as restricting vehicle travel, are more difficult to enforce, tend to reduce individual mobility, and may require major changes in driving habits. By significantly reducing the emission of HC and CO from in-use motor vehicles in Ohio, an I/M program will enhance the likelihood of the attainment of NAAQS.

The Clean Air Act Amendments of 1977 have specific provisions that require the establishment of inspection/maintenance programs. According to the U.S. EPA, the state must submit by January 1979 revisions to its State Implementation Plan (SIP), which specifies methods to achieve the National Ambient Air Quality Standards. These methods include control of stationary sources of air pollution and various transportation control measures whose objective is to reduce vehicle miles traveled (VMT) and hence reduce pollution from sources such as motor vehicles. If, in these revisions, the state cannot demonstrate attainment of the NAAQS by 1982 by using all reasonably available pollution control measures, then an extension to 1987 can be requested if several provisions are met. One such provision is the establishment of a specific schedule for the implementation of an I/M program. Because it is doubtful that the NAAQS can be attained in many areas of Ohio through other measures, an I/M program is likely to be required.

What are Inspection and Maintenance Programs?

Since 1968, automobiles built in or imported into the U.S. have had to meet certain exhaust emission standards. Generally, these standards are achieved through the use of emission control equipment and by appropriate adjustment of various engine components. Analyses have shown that, over time, the emission control equipment and other key engine components tend to lose proper adjustment and thus become less effective. Also, studies throughout the U.S. conducted by U.S. EPA have shown that tampering or removal of emissions controls and fuel switching, which ruins catalytic converters, have become widespread practices. With an I/M program in effect, most light duty cars and trucks would be required to be inspected annually to determine whether or not their emissions controls are functioning properly and to ensure that the carburator and ignition are adjusted properly. Vehicles found to be out of adjustment or tampered with are required to be properly adjusted or repaired.

BACKGROUND OF THIS STUDY

In order to meet the requirements of the Clean Air Act Amendments of 1977 in establishing a schedule of implementation for an I/M program in Ohio, the Ohio Inspection/Maintenance Advisory Group was established early in 1978. The Ohio I/M Advisory Group met in March 1978 to initiate action on considering various possible I/M options and to select the option most suited to the needs and desires of the State of Ohio. The Advisory Group is composed of members of various agencies including representatives of the Ohio Environmental Protection Agency, the Department of Highway Safety which includes the Bureau of Motor Vehicles and the State Highway Patrol, the Department of Transportation, the Attorney General's Office, the Governor's Office, and the Department of Energy.

The initial effort of the I/M Advisory Group was the development of background data regarding the technical and administrative aspects of I/M programs. A summary report describing I/M program elements and other states' experience in I/M and various technical memoranda were produced to assist in the selection of a limited number of I/M options. In April 1978 the Advisory Group selected seven I/M program options, which were subsequently evaluated and compared in terms of benefits, costs and effectiveness. Among the variables considered in looking at the different options were whether to have the state, a private contractor or licensed private garages conduct the emissions inspection; whether to have the program cover only the urbanized counties (12 to 18 counties) or to have full statewide coverage; whether to use a simple idle test or more comprehensive loaded mode test; what enforcement procedure would be best, motor vehicle registration or using stickers and ticketing; whether or not to have the Ohio State Highway Patrol conduct a random roadside emission test for vehicles in the rural areas.

The findings of this report indicated that a state- or contractor-run inspection would cost the average motorist very close to the same amount differing only by about $0.20 per inspection. (The contractor would cost approximately $0.20 more because of taxes paid to local governments for its land and buildings.) The private garage approach would cost about the same as the state or contractor depending on the level of participation of private garages. As more garages participated in the program, the share of the total vehicle population coming to each station is reduced, thereby requiring each station to charge higher fees to break even. In terms of emission reduction benefits, the statewide programs clearly brought greater reduction in emissions as more vehicles would be included in the statewide program. There would probably be a very similar level of reduction among the three organizational approaches, state, contractor or private garage. The random roadside emission test procedure would not bring the same emission credits from the U.S. EPA.

Other issues were raised, however, that indicated potential indirect benefits from the centralized lane approach as opposed to the decentralized garage options. Having a licensed private garage conduct both inspections and the necessary repairs for failed vehicles, raises potentially serious conflict of interest questions. Given the adverse publicity concerning alleged unethical repair practices in the repair industry and given the technical difficulties in maintaining quality control on the several thousand emission analyzers across the state, this option was considered to have significant disadvantages in comparison to state or contractor centralized lanes. Quality control and supervision would be much better and uniformity of inspection results would consequently be far greater in centralized lanes.

Another issue that separates the options concerns the commitment of large numbers of state employees. In the state-run approach there would be a far greater number of new state employees, namely, the actual emissions inspectors. This employment issue was seen as potentially significant in view of the desirability keeping the commitment of state manpower to a minimum. Moreover, the contractor approach allows for the option of state cancellation either during or at the end of the 5-year initial period if the state wanted to take over the program itself.

As a result of the findings of this report, executive workshops, OEPA staff contacts with existing I/M programs, and other inputs, the Ohio I/M Advisory Group selected a final option for evaluation. A more detailed evaluation of benefits and costs of this option is the subject of this report, entitled The Phase III Report.

OPTION DEFINITION

The Ohio I/M Advisory Group has selected an I/M program for the state that will incorporate the following characteristics:

- Organizational Approach: System owned and operated by a private contractor.
- Geographic Coverage: Statewide.
- Test Type: Loaded mode test based on the Clayton Key Mode procedure, with emission measurements taken at three different engine speeds including idle, but pass-fail criteria based upon idle mode results only.

- Frequency of Inspection: Annual.
- Enforcement: Tied into motor vehicle registration procedures such that a vehicle failing inspection will not be allowed to register.
- Program Administration: Ohio Environmental Protection Agency with assistance from the Ohio Department of Highway Safety.
- Stringency: 20 percent of the tested vehicle oppulation will fail and need maintenance.
- Vehicles included in program:
  - light-duty vehicles (passenger cars)
  - light-duty trucks weighing less than 8,500 lb GVW
  - farm trucks
  - diesel-powered vehicles weighing less than 8,500 lb GVW
- Vehicles exempt from inspection:
  - trucks and buses weighing over 8,500 lb GVW
  - motorcycles and motorized bicycles
  - permanent 4-wheel drive vehicles
  - off-the-road vehicles not used on public highways
  - racing cars used solely for exhibition purposes and not on public highways
  - certified research vehicles
  - certified antique vehicles
- Upon transfer of title, all vehicles included in the program must be reinspected.
- A certificate of compliance with state emission standards will be valid for 90 days to allow plenty of time for the public to repair failed vehicles and pass the test.

EMISSIONS INSPECTION SCENARIO

To illustrate how the inspection process will work, the following description of the procedure is offered.

The requirement for an emission inspection will be related to the annual registration procedure; that is, emissions inspections will generally be required when registration renewals are due. Prior to the renewal date, the motorist will receive the renewal forms from the Bureau of Motor Vehicles. If the vehicle is exempt from inspection he will go to a Deputy Registrars office and complete the registration renewal process. Alternatively, he could mail the form to the Bureau of Motor Vehicles in Columbus. If his vehicle is not exempt, he proceeds to the official inspection station.

At the station, the motorist will present his renewal form from which certain information are obtained to define the emission standards for the particular vehicle being tested. Motor vehicles proceed through the test lanes where the actual emission measurements are performed. Based on the vehicle data that are at the beginning of the test, pass-fail criteria are automatically adjusted to the specific vehicle being tested. The registration form is stamped if the vehicle passes the test and the registration process proceeds as usual.

If the vehicle fails, the computer prints out a form stating which standards are being exceeded, and by how much. The owner will be advised as to the probable cause for failure, and required to have the vehicle repaired and reinspected prior to obtaining his registration renewal. Generally, repairs consist of merely adjusting the carburator or a simple tune-up. Once repairs are completed, the vehicle is taken back to a test facility for a free reinspection; if it passes, the registration form is appropriately stampted and the renewal process proceedes as mentioned above. Should the motorist encounter a problem at any point in the process, complaint mechanisms will be provided to deal with it. Consumer hotlines will be established to direct individuals with questions or complaints to appropriate State agencies. Complaints regarding the inspection process will be directed to an OEPA hotline whereas repair complaints will go to the Attorney General's Office in accordance with existing procedures.

I/M PROGRAM NETWORK

Vehicle Population Projections

Estimates of county motor vehicle registrations for each year from 1982 through 1987 were made as a first step to defining the overall facilities network requirements. There estimates were derived from statistics provided by Ohio Environmental Protection Agency and Ohio Bureau of Motor Vehicles. The number of inspectable vehicles projected for the State of Ohio by region is shown below in Table 1.

TABLE 1. INSPECTABLE VEHICLE POPULATION ESTIMATES FOR 1982 AND 1987

OEPA region	1982	1987
Northwest	1,388,000	1,540,000
Northeast	2,856,000	3,167,000
Central	934,000	1,036,000
Southeast	789,000	876,000
Southwest	1,862,000	2,065,000
Total	7,829,000	8,684,000

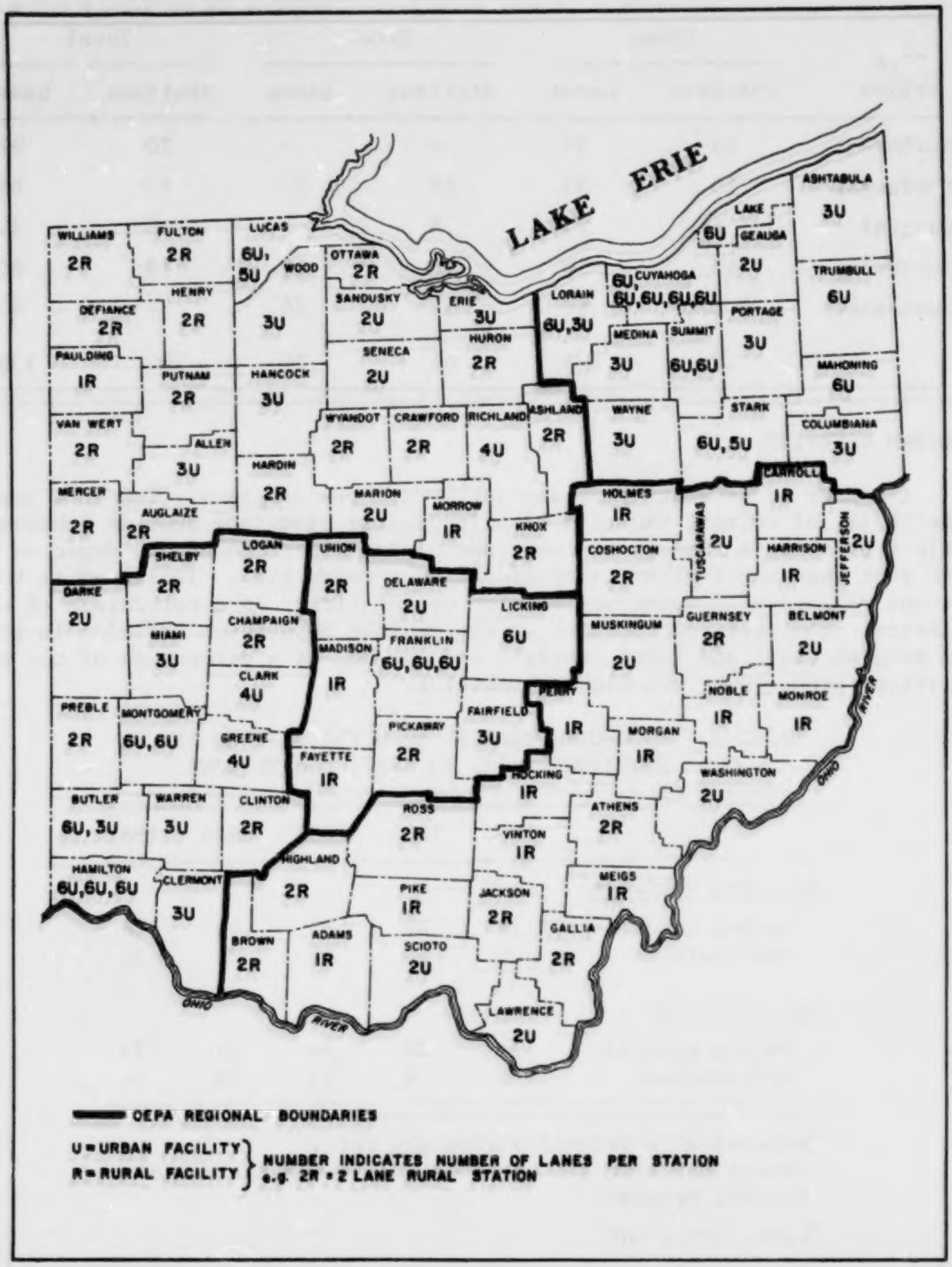
Then, to estimate the number of actual inspections per year, the vehicle population was increased by 20 percent to allow for retest of failed vehicles. This resulted in the estimated yearly inspections as shown in Table 2.

TABLE 2. INSPECTIONS PERFORMED ANNUALLY, 1982 - 1987

Year	Inspection performed
1982	9,396,000
1983	9,593,000
1984	9,793,000
1985	9,998,000
1986	10,207,000
1987	10,420,000
Average	9,901,000

Network of Inspection Facilities

Two types of inspection facilities are being considered for the statewide I/M program. In more densely populated counties, urban stations were designed to test one vehicle every 2 minutes or approximately 42,000 vehicles per year; in less populated areas with fewer vehicles, rural stations would test one vehicle every 3 minutes or about 28,000 vehicles per year. The rural stations, which are smaller and employing fewer people, are more cost effective for less populated areas. The numbers and types of stations per region are shown below in Table 3. The actual numbers of stations and station types are shown in Figure 1.


LAKE ERIE
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FULTON 2R
LUCAS 6U, 5U
WOOD 3U
OTTAWA 2R
SANDUSKY 2U
ERIE 3U
LORAIN 6U,3U
CUYAHOGA 6U 6U,6U,6U,6U
LAKE 6U
GEAUGA 2U
ASHTABULA 3U
TRUMBULL 6U
DEFIANCE 2R
HENRY 2R
SENECA 2U
HURON 2R
MEDINA 3U
SUMMIT 6U,6U
PORTAGE 3U
MAHONING 6U
PAULDING 1R
PUTNAM 2R
HANCOCK 3U
WYANDOT 2R
CRAWFORD 2R
RICHLAND 4U
ASHLAND 2R
WAYNE 3U
STARK 6U, 5U
COLUMBIANA 3U
VAN WERT 2R
ALLEN 3U
HARDIN 2R
MARION 2U
MORROW 1R
KNOX 2R
HOLMES 1R
CARROLL 1R
MERCER 2R
AUGLAIZE 2R
TUSCARAWAS 2U
HARRISON 1R
JEFFERSON 2U
SHELBY 2R
LOGAN 2R
UNION 2R
DELAWARE 2U
LICKING 6U
COSHOCTON 2R
DARKE 2U
MIAMI 3U
CHAMPAIGN 2R
MADISON 1R
FRANKLIN 6U,6U,6U
MUSKINGUM 2U
GUERNSEY 2R
BELMONT 2U
CLARK 4U
PERRY 1R
NOBLE 1R
MONROE 1R
PREBLE 2R
MONTGOMERY 6U,6U
GREENE 4U
FAYETTE 1R
PICKAWAY 2R
FAIRFIELD 3U
MORGAN 1R
WASHINGTON 2U
HOCKING 1R
BUTLER 6U, 3U
WARREN 3U
CLINTON 2R
ROSS 2R
ATHENS 2R
VINTON 1R
HAMILTON 6U,6U,6U
CLERMONT 3U
HIGHLAND 2R
PIKE 1R
JACKSON 2R
MEIGS 1R
GALLIA 2R
BROWN 2R
ADAMS 1R
SCIOTO 2U
LAWRENCE 2U
OHIO RIVER
OEPA REGIONAL BOUNDARIES
U = URBAN FACILITY
R = RURAL FACILITY
NUMBER INDICATES NUMBER OF LANES PER STATION
e.g. 2R = 2 LANE RURAL STATION

Figure 1. Station configurations, I/M network.

TABLE 3. OHIO I/M STATION NETWORK

OEPA region	Urban Stations	Urban Lanes	Rural Stations	Rural Lanes	Total Stations	Total Lanes
Northeast	20	97	—	—	20	97
Northwest	10	33	17	32	27	65
Central	6	29	4	6	10	35
Southwest	13	58	5	10	18	68
Southeast	8	16	19	26	27	42
	57	233	45	74	102	309

PROGRAM BENEFITS

A number of benefits are associated with I/M programs. The most important benefit is, of course, the reduction in vehicle emissions that is achievable. Table 4 presents a summary of the types of emissions reductions expected during each year that the program is in operation through 1987. Indicated is the percent reduction in emissions for two cases; first, as a percentage of the emissions from just that portion of the vehicle population included in the I/M program (cars and light trucks), and second, as a percentage of the total emissions produced by all highway vehicles.

TABLE 4. PROJECTED PERCENT REDUCTIONS IN CO AND HC EMISSIONS, 1983 TO 1987, DUE TO I/M*

	1983	1984	1985	1986	1987
Affected Vehicles†					
Carbon monoxide	19	27	33	40	46
Hydrocarbons	6	10	16	22	29
All Vehicles					
Carbon monoxide	14	20	24	29	33
Hydrocarbons	5	8	13	18	24

*Assumes a 20 percent stringency rate.
Reductions over and above the Federal Motor Vehicle Control Program.

†LDVs, LDT_1, LDT_2.

The effects on emission reductions of increasing the stringency (failure rate) to 30 or 40 percent were also studied. Increasing the stringency level above 20 percent results in only very slight additional reductions in HC or CO. The reason for this is that 20 percent failure, nearly all of the gross pollution emitters are failed, whereas the additional cars that fail when the standatds are set above this level only marginally exceed the standards. Repairing these vehicles, then, has only a marginal effect on emission reductions because the worst polluters were already identified and reapired at the 20 percent level. The figures shown in Table 4 demonstrate that the proposed I/M program will achieve emission reductions of 46 percent and 29 percent for CO and HC, respectively, more than the 25 percent minimum required by U.S. EPA.

Another benefit associated with I/M is improved fuel economy for vehicles that undergo maintenance associated with the program. Studies have shown that improvement on the order of 5 to 10 percent can be expected. For the purposes of this study, it is assumed that the fuel economy improvement for vehicles that fail the emissions test and therefore undergo maintenance will be 7 percent averaged over a year. Applying this to the projected vehicle population for the entire state in 1987, the failure rate chosen — 20 percent, and the relative travel distribution by various model year vehicles, it is estimated that during 1987, approximately 44.6 million gallons of gasoline would be saved as a result of the I/M program. Assuming further that the cost of gasoline in 1987 will be $0.80 per gallon, the fuel cost savings associated with the 44.6 million gallons of fuel conserved is $37.7 million. This translates to an average savings of $22.00 per failed vehicle.

The effects of inspection and maintenance programs on vehicle performance and life are currently under study. Preliminary analyses in this area have focused on various vehicle fleets and indicate that I/M does have a positive effect on both vehicle performance and vehicle life, although specific quantitative statistics are not yet available.

The implementation of a statewide contractor operated I/M program in Ohio would result in the creation of 1055 jobs in the private sector. The majority of the positions would be the 847 station inspectors at the 57 urban and 45 rural stations. This translates to $13.4 million in salaries which includes $12.8 million for station level personnel and $0.6 million for regional and state level contractor management personnel.

PROGRAM ADMINISTRATION AND PERSONNEL REQUIREMENTS

An administrative network was derived for the proposed I/M programs. The Ohio Environmental Protection Agency would have the primary responsibility for planning, implementation and supervision of the overall program. The Attorney General's Office, Consumer Protection Division, would handle consumer complaints concerning the private repair industry. The Department of Highway Safety, Bureau of Motor Vehicles deputy registrar system would also be involved because the enforcement procedure is incorporated into the motor vehicle registration process. The contractor who actually builds and runs inspection facilities also must have an organizational network in this large statewide inspection system.

The personnel have been broken down into five separate categories as follows:

1. State of Ohio — Statewide Responsibility. Under this category are those employees of the State of Ohio who exercise statewide control over various aspects of the program including overall administration and supervision as well as specific functional responsibilities.

2. State of Ohio — Regional Responsibility. Under this category are those employees of the State of Ohio who exercies control over a single OEPA region in which they are stationed.

3. Contractor — Statewide Responsibility. Under this category are those employees of the contractor who exercise statewide control over various aspects of the program with the guidance and direction of OEPA. On the state level, the contractor would employ a number of personnel having functions similar to, and coordinating their activities very closely with, the state employees in category one.

4. Contractor — Regional Responsibility. Under this category are those contractor employees who exercise responsibility over a program function within a single OEPA region.

5. Contractor — Local Responsibility. Under this category would be all the contractor employees at the inspection station level.

The number of employees estimated for the I/M program are shown in Table 5.

TABLE 5. PROGRAM EMPLOYEES

Personnel category	Number of employees
State — Statewide	12
State — Regional	25
State — Total	37
Contractor — Statewide	8
Contractor — Regional	51
Contractor — Local	996
Contractor — Total	1055

SUPPORTING PROGRAMS

In order for a basic I/M program to be successfully implemented and operated, a number of supporting programs have to be implemented as well. These programs include:

- quality assurance, which focuses on improving the quality and uniformity of emission inspections and the repair process;
- mechanic training, which increases the quality of emission repair work, thus providing consumer benefits;
- consumer protection, which provides a vehicle for the consumer to seek recourse if he is treated unfairly either during the inspection or maintenance phase;
- enforcement, which assures uniform compliance; and
- public information, which provides comprehensive information to the public concerning the need for and benefits of I/M, as well as disseminates necessary information such as inspection facility locations and hours of operations, etc.

PROGRAM COSTS

A detailed cost analysis of the statewide contractor operated I/M program as defined earlier was conducted. Appropriate amortization factors were applied to the cost elements to derive an annualized cost. An estimate of the minimum inspection fee (breakeven fee) was calculated to be constant for the initial 5-year inspection period from 1982 through 1987. This breakeven fee was estimated by dividing the total annualized costs by the average number of registrations in this period — a free retest is assumed. A 7 percent inflation rate is assumed. The fee is shown below:

Total annualized costs	Average annual registrations	Breakeven fee estimate
$45,546,000	8,251,000	$5.52

This fee estimate does not include any profit or fee, which would be negotiated between the contractor and the state. Based on other similar I/M programs, this fee would probably amount to 10 to 15 percent of the breakeven fee shown above, or about $6.07 to $6.35. Again, the first retest would be free.

IMPLEMENTATION SCHEDULE

In order to comply with the requirements of the Clean Air Act, the State of Ohio must meet certain scheduling criteria for the implementation of the program. For instance, most states will be required to have enabling legislation passed by 1 July 1979. Also, for the option selected by the State, the mandatory inspection and maintenance phase must begin by 31 December 1981.

The deadlines obviously control many other facets of the implementation schedule that the State must follow. The implementation schedule is shown in Table 6.

TABLE 6. OHIO I/M IMPLEMENTATION SCHEDULE

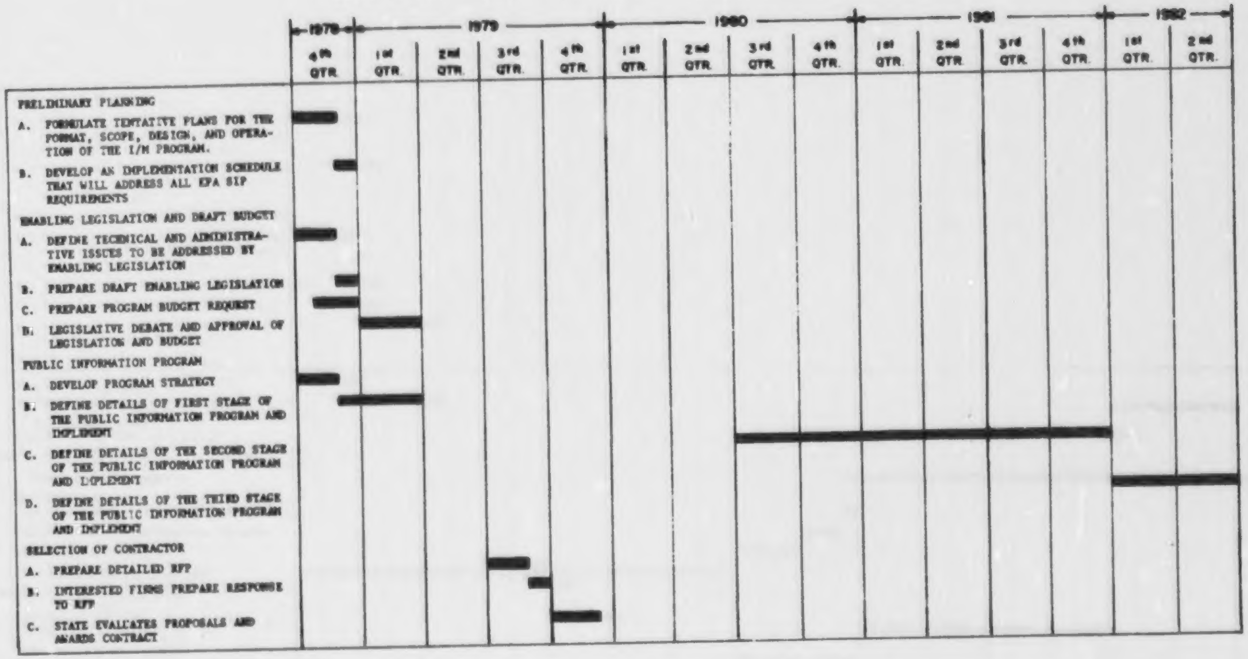
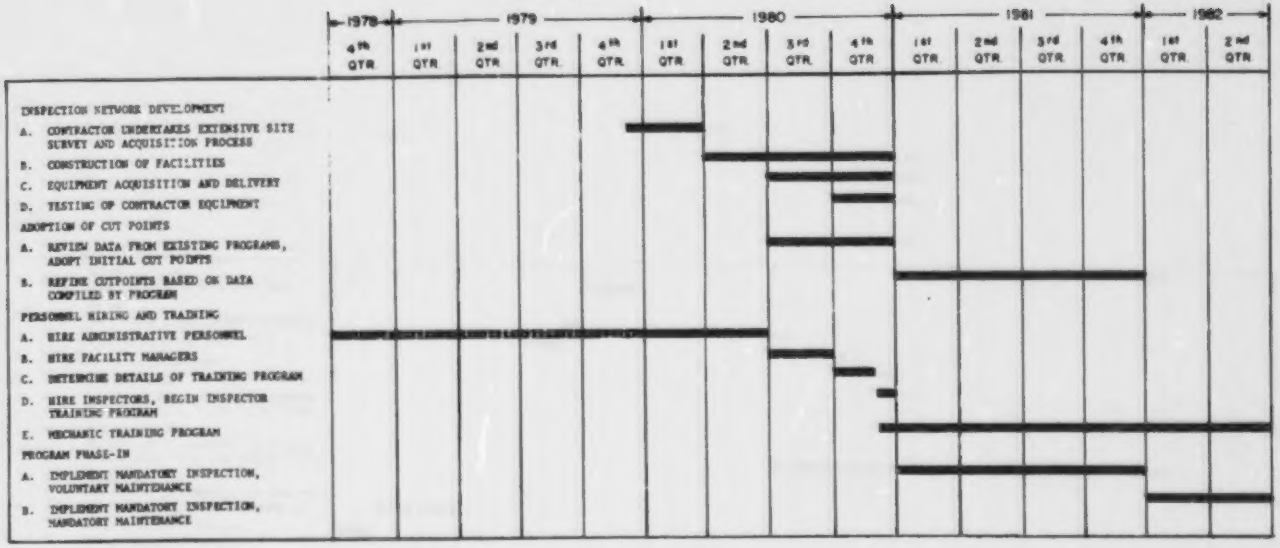


TABLE 6 (continued)



SECTION 2

INTRODUCTION

BACKGROUND

Need for Inspection/Maintenance Program

Recent ambient air quality data for the State of Ohio indicates widespread and frequent violations of the National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO) and photochemical oxidants (O_x) in 63 counties.[1] These national standards have been established in order to protect the health and welfare of the population.[2] Both CO and O_x are gases which in sufficient concentrations in the atmosphere are potentially harmful to the public health. Major sources if CO and O_x in Ohio are motor vehicles. Carbon monoxide is directly produced by gasoline-burning internal combustion engines and photochemical oxidants are indirect products, formed through a complex series of atmospheric reactions in which two other direct produces of combustion, unburned gaseous hydrocarbons (HC) and oxides of nitrogen (NO_x) combine in the presence of sunlight. Inspection/maintenance programs are a cost-effective strategy to reduce these emissions from motor vehicles. Other strategies that have been suggested, such as restricting travel, are more difficult to enforce, tend to reduce individual mobility, and may require major changes in driving habits by significantly reducing the emission of HC and CO from in-use motor vehicles in Ohio, and I/M program will enhance the likelihood of the attainment of NAAQS.

The Clean Air Act Amendments of 1977 have specific provisions that require the establishment of inspection/maintenance programs. According to the U.S. EPA, the state must submit by January 1979 revisions to its State Implementation Plan (SIP)[3] which specify methods to achieve the National Ambient Air Quality Standards. These methods include control of stationary sources of air pollution and various transportation control measures whose objective is to reduce vehicle miles traveled (VMT) and hence to reduce pollution by mobile sources such as motor vehicles. If in these revisions, the state cannot demonstrate attainment of the NAAQS by 1982 by using all reasonably available pollution control measures, then, an extension to 1987 can be requested, if several provisions are met. One such provision is the establishment of a specific schedule for the implementation of an I/M program. Because it is doubtful that the NAAQS can be attained in many areas of Ohio through other measures, an I/M program is likely to be required.

Background of This Study

In order to meet the requirements of the Clean Air Act Amendments of 1977 in establishing a schedule of implementation for an I/M program in Ohio, the Ohio Inspection/Maintenance Advisory Group was established early in 1978. The federal guidelines for Inspection/Maintenance programs are presented in Appendix C. The Ohio I/M Advisory Group met in March 1978 to initiate action on considering various possible I/M options and to select the option most suited to the needs and desires of the State of Ohio. The Advisory Group is composed of members of various agencies including representatives of the Ohio Environmental Protection Agency, the Department of Highway Safety which includes the Bureau of Motor Vehicles and the State Highway Patrol, the Department of Transportation, the Attorney General's Office, the Governor's Office, and the Department of Energy.

The initial effort of the Advisory Group was the development of data regarding the technical and administrative aspects of I/M programs. There have been several sources of data used by the Advisory Group that has been helpful in their decisions. Among them were executive workshops trips to study existing I/M programs in Cincinnati, Ohio, Portland, Oregon, and Phoenix Arizona. The staff of the Ohio EPA has maintained contact with many of the I/M programs throughout the country and this has provided useful information. Finally, the consultant responsible for this report and the earlier reports discussed below provided significant input to the Advisory Group through reports, presentations, and technical memoranda.[4,5,6]

A summary report describing I/M program elements and other states experience in I/M and various technical memoranda were produced to assist in the selection of a limited number of I/M options.[7] In April 1978 the Advisory Group selected seven I/M program options, which were subsequently evaluated and compared in terms of benefits, costs and effectiveness. Among the variables considered in locking at the different options were whether to have the state, a private contractor or licensed private garages conduct the emissions inspection; whether to have the program cover only the urbanized counties (12 to 18 counties) or to have full statewide coverage; whether to use a simple idle test or more comprehensive loaded mode test; what enforcement procedure would be best, motor vehicle registration or using stickers and ticketing; whether or not to have the Ohio State Highway Patrol conduct a random roadside emission test for vehicles in the rural areas. The Phase II Report, then, consisted of comparative evaluation of the seven options listed in Table 7.[8]

The findings of this report indicated that a state- or contractor-run inspection would cost the average motorist very close to the same amount differing only by about $0.20 per inspection. (The contractor would cost approximately $0.20 more because of taxes paid to local governments for its land and buildings.) The private garage approach would cost about the same as the state or contractor depending on the level of participation of private garages. As more garages participated in the program, the share of the total vehicle population coming to each station is reduced, therby requiring each station to charge higher fees to break even. In terms of emissions reduction benefits, the statewide programs clearly brought greater reduction in emission

TABLE 7. SEVEN OHIO I/M PROGRAM OPTIONS

THE SEVEN OPTIONS ARE AS FOLLOWS:

- OPTION I
  - STATEWIDE COVERAGE
  - CONTRACTOR ADMINISTERS CENTRALIZED LANES IN URBAN AREAS
  - PRIVATE GARAGES IN RURAL AREAS
    - ALTERNATE A - 12 URBAN COUNTIES - ALL COUNTIES GREATER THAN 200,000
    - ALTERNATE B - 18 URBAN COUNTIES - 12 COUNTIES GREATER THAN 200,000 PLUS 6 ADJACENT COUNTIES
- OPTION II
  - STATEWIDE COVERAGE
  - STATE ADMINISTERS CENTRALIZED LANES IN URBAN AREAS
  - PRIVATE GARAGES IN RURAL AREAS
    - ALTERNATE A - 12 URBAN COUNTIES
    - ALTERNATE B - 18 URBAN COUNTIES
- OPTION III
  - URBAN COUNTIES ONLY
  - CONTRACTOR ADMINISTERS CENTRALIZED LANES
    - ALTERNATE A - 12 URBAN COUNTIES
    - ALTERNATE B - 18 URBAN COUNTIES
- OPTION IV
  - URBAN COUNTIES ONLY
  - STATE ADMINISTERS CENTRALIZED LANES
    - ALTERNATE A - 12 URBAN COUNTIES
    - ALTERNATE B - 18 URBAN COUNTIES
- OPTION V
  - STATEWIDE COVERAGE
  - CONTRACTOR ADMINISTERS CENTRALIZED LANES IN URBAN AREAS
  - STATE HIGHWAY PATROL CONDUCTS RANDOM INSPECTION IN RURAL AREAS
    - ALTERNATE A - 12 URBAN COUNTIES
    - ALTERNATE B - 18 URBAN COUNTIES
- OPTION VI
  - STATEWIDE COVERAGE
  - STATE ADMINISTERS CENTRALIZED LANES IN URBAN AREAS
  - STATE HIGHWAY PATROL CONDUCTS RANDOM INSPECTION IN RURAL AREAS
    - ALTERNATE A - 12 URBAN COUNTIES
    - ALTERNATE B - 18 URBAN COUNTIES
- OPTION VII
  - STATEWIDE COVERAGE
  - PRIVATE GARAGE TESTING IN URBAN AND RURAL AREAS
  - STATE OR CONTRACTOR CONDUCTS SURVEILLANCE/QUALITY CONTROL OF GARAGES

as more vehicles would be included in the statewide program. There would probably be a very similar level of reduction among the three organizational approaches, state, contractor or provate garage. The random roadside emission test procedure would not bring the same emission credits from the U.S. EPA.

Other issues were raised, however, that indicated potential indirect benefits from the centralized lane approach as opposed to the decentralized garage options. Having a licensed private garage conduct both inspections and the necessary repairs for failed vehicles, raises potentially serious conflict of interest questions. Given the adverse publicity concerning alleged unethical repair practices in the repair industry and given the technical difficulties in maintaining quality control on the several thousand emission analyzers across the state, this option was considered to have significant disadvantages in comparison to state or contractor centralized lanes. Quality control and supervision would be much better and uniformity of inspection results would consequently be far greater in centralized lanes.

Another issue that separates the options concerns the committment of large numbers of state employees. In the state-run approach there would be a far greater number of new state employees, namely, the actual emissions inspectors. This employment issue was seen as potentially significant in view of the desirability keeping the commitment of state manpower to a minimum. Moreover, the contractor approach allows for the option of state cancellation either during or at the end of the 5-year initial period if the state wanted to take over the program itself.

The objective of the study being reported here is to analyze the specific requirements of the option selected, primarily in terms of costs, benefits, and resource requirements, and consider in detail various tangential factors and issues that are also relevant. The major difference in this effort and the effort in Phase 2 is that, whereas the earlier effort focused on providing a comparative analysis of several options and therefore was rather general in treating several aspects of program implementation and operation, this effort focuses on one specific program and provides a more detailed analysis of many program factors.

DESCRIPTION OF INSPECTION/MAINTENANCE PROGRAMS

Federal Motor Vehicle Control Program

Beginning with 1968 model-year vehicles, automobiles manufactured in or imported into the U.S. have had to comply with emission standards specified in the Federal Motor Vehicle (emission) Control Program (FMVCP). Under this program, maximum emission rates were established for new vehicles, and manufacturers had to demonstrate, through an auditing program, that their vehicles were in compliance with these emission limits. The emission standards specified by the FMVCP required progressively more stringent control of emissions with each subsequent model year.

The FMVCP consists of three parts including certification of prototype vehicles prior to actual production, selective enforcement testing of vehicles at the assembly line, and testing of in-use vehicles around the country to discover design defects in emission controls as well as to provide data to recall vehicles with inadequate or defective emission devices. Federal testing of in-use vehicles throughout the United States, unfortunately, has demonstrated that motor vehicles are not meeting the emission standards for which they are designed. The primary reasons the vehicles exceed the standards include improper or inadequate maintenance, tampering, and defective emission control devices. Regardless of the cause, it has become clear that some in-use vehicle emission inspection programs are necessary to ensure that the emission controls continue to operate as they were intended over their useful life.

Description of Inspection/Maintenance Programs

Inspection/maintenance programs, thus, evolved through the need to ensure that in-use vehicles meet the emission standards for which they were designed. I/M programs consist of two basic components. In the inspection phase, the motor vehicle exhaust emissions are measured and compared to a test standard that relates to the model year of the vehicle. In the second phase, that is maintenance, those vehicles failing to meet the applicable standards are required to undergo repair or maintenance until the vehicle is able to pass the test.

I/M is not a new strategy and much operation information has been collected documenting the effectiveness of the program to reduce motor vehicle emissions. Several states now have I/M programs in operation and several are about to be implemented.

The major issues that need to be addressed in setting up an I/M program include the following:

1. Organizational approach
2. Geographical coverage
3. Type of emissions test - idle or loaded
4. Frequency of inspection
5. Enforcement procedure
6. Vehicles to be tested
7. Vehicles to be exempted
8. Data handling procedures
9. Adjunctive programs (e.g., public information, public convenience, consumer protection, warranty protection, quality assurance, mechanics training, program enforcement considerations)

Organizational Approach

A variety of approaches have been used to run I/M programs, but the major types fall generally into three organizational categories as follows:

1. Government - Centralized test facilities operated by state, city, or local government (as in New Jersey; Cincinnati, Ohio; Portland, Oregon; and Chicago, Illinois).

2. Contractor - Centralized facilities operated by a private corporation under contract to a government (as in Maricopa and Pima Counties, Arizona).

3. Private Garage - Decentralized facilities operated by private automobile service garages, certified or licensed by a government (as in Rhode Island and Nevada).

In addition to these primary types, there can be combinations. For example, a decentralized private system may also include one or several state-run facilities as quality control measures and to discourage unethical or ineffective testing or maintenance.

In Rhode Island, the system is the decentralized private garage approach but the state has one publicly run "challenge station" which acts as a referee to retest unsatisfied customers from any private station.

Each organizational approach has various advantages and disadvantages. The centralized state-run or contractor approaches allow for greater accuracy in testing, better quality assurance, and better consumer protection, but the centralized cases incur higher capital costs. The decentralized private garage approach, if properly planned may offer greater consumer convenience but due to the lack of separation between the inspection and maintenance function may offer less consumer protection. Also, there may be problems in quality assurance due to variability in testing equipment and calibration practices. The costs and benefits of the approaches are discussed in detail in the Phase 2 Report entitled, "Evaluation of Motor Vehicle Inspection and Maintenance Programs in Ohio."

Geographic Coverage

Another important issue in developing an I/M program concerns the geographical coverage of the program. Geographic coverage refers to the areas in which registered vehicles are subject to I/M. The primary reason for inclusion or exclusion of an area in I/M program coverage has to do with the local motor vehicle population density as well as the severity of the air pollution problem.

The U.S. EPA has issued guidance to the states concerning minimum standards for geographic coverage. In an EPA memorandum entitled "Inspection/Maintenance Policy" dated 17 July 1978, David A. Hawkins, Assistant Administrator for Air and Waste Management, issued the following statement concerning geographic coverage:

> "I/M should focus on metropolitan areas and should include the entire urbanized area and adjacent fringe areas of development. Boundaries of the area affected may be adjusted if an equivalent emission reduction

> is achieved. For urbanized areas of 200,000 population or greater which need I/M to obtain an extension of the 1982 attainment data, full mandatory I/M must be implemented by December 31, 1982 for new centralized programs, and December 31, 1981 for all other programs. Statewide programs are encouraged, especially for those states which are small and highly urbanized.
>
> It should be emphasized that all nonattainment areas must have SIP's which are adequate to attain and maintain the National Ambient Air Quality Standards (NAAQS) by 1982 or by no later than 1987 should an acceptable nonattainment demonstration be made. For areas under 200,000, EPA will not at this time automatically require I/M schedules in 1979 as a condition for SIP approval or an extension. However, areas under 200,000 still have to attain and maintain NAAQS as expeditiously as practicable, and I/M is encouraged as a means of helping to provide for an adequate SIP. EPA will review the need for I/M in areas under 200,000 after the 1979 SIP revisions are submitted, and will consider additional requirements at that time."

Type of Emissions Test

An important issue in I/M programs concerns the type of emissions test, idel- or loaded-mode test. Basically, the idle-mode test consists of measuring gases from the vehicle at constant idle speed or at idle after the vehicle exhaust system has been purged by having it run at high idle (usually 2500 rpm). In the loaded-mode test, the drive wheels are placed on a chassis dynamometer which simulates actual driving conditions and the vehicle is driven at various speeds, such as 50 mph, 30 mph and then allowed to idle. Exhaust gas measurements are taken in each driving mode and at idle, although for the pass-fail decision the idle measurement is commonly used. There are several variations on the loaded-mode test, but the important distinctions concern the test accuracy, diagnostic data provided by the test, its ability to measure various exhaust gases, and the test time. If the idle test includes a high idle purge, it is approximately equal to the loaded-mode test in its ability to identify the vehicles exceeding the appropriate standards. The loaded-mode provides superior diagnostic information by simulating actual driving conditions during which many of the emission controls become active. Furthermore, the loaded-mode test can identify nitrogen oxide gases which the idle test cannot, since these gases are not easily detected at idle speed.

The loaded-mode may take 1/2 minute longer than the idle test, but if the idle test includes a purging high idle period, they are approximately equal. This issue of test time becomes critical when considering the design and cost of a large centralized network of inspection stations, because the more efficient and less time consuming test, other factors being equal, allows for a shorter throughput capacity per lane. This allows for greater lane capacity and the need to build fewer stations. A more detailed discussion of the idle versus loaded-mode test is provided in the Phase 2 report.

BASIS AND ORGANIZATION OF THIS REPORT

Again, the intent here is to report the results of a rather detailed analysis of the particular I/M program configuration that is being considered for implementation in the State of Ohio. The general elements included in the analysis are (1) benefits, (2) personnel requirements, (3) adjunctive program requirements, (4) legislative requirements, (5) costs, and (6) implementation scheduling.

The general philosphy used in developing the analysis considered the fact that a number of different resources had to be utilized in order to produce an assessment that was both comprehensive in nature and specific to the State of Ohio. In this connection, it was considered not only appropriate, but essential to include several State agencies as sources of data and to conduct discussions with various State officials to solicit their views on different issues that are germane to the I/M program in the State. Much of the technical information generally available in the literature and from the U.S. Environmental Protection Agency was reviewed also as part of the effort, and incorporated where appropriate. Other sources of technical information used include disucssions with both state officials and private contractors currently involved with running I/M programs throughout the U.S. A substantial amount of effort was also expended on original research utilizing information derived from the above-mentioned sources.

The report is divided into 11 principal sections including this introduction. The option being considered here is defined and discussed in detail in Section 3. Section 4 provides a discussion of the various benefits associated with implementation of the I/M program, in terms of both direct and indirect benefits, and also indicates the associated disbenefits. The resource requirements for the program are discussed in Section 5. Given prime consideration here are personnel requirements for both implementation and operation of the inspection program and operation and administration of the adjunctive programs such as consumer protection, quality assurance, and others. Section 6 provides a detailed discussion of the several supporting programs that are required. Included are discussions of (1) quality assurance, (2) mechanics training, (3) consumer protection, (4) program enforcement, and (5) public information programs. Section 6 discusses the technical requirements for state legislation and mentions issues relevant to barriers or obstacles that can be encountered in the legislative process. The costs associated with implementing the program are discussed in detail in Section 8. The discussion here is in terms of both actual program costs by category, and the inspection fee requirements. Section 9 presents an analysis of the implementation staging and scheduling, as well as providing discussion concerning barriers to implementation. Section 10 provides recommendations concerning the direction that subsequent efforts should take with regard to program implementation. Section 11 is a summary in fairly good detail of the entire report.

In the appendices are included discussions on detailed descriptions of the methodology for calculating emission inventories, detailed methodologies for estimating fuel savings, federal I/M guidelines, detailed tax calculations, and a detailed 18-county emission reduction inventory.

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7. Ramsay, D. B. and T. Midurski. Sumary Paper on Inspection and Maintenance. GCA Corporation, GCA/Technology Division, Bedford, Mass. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, N.C. March 1978.

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SECTION 3

PROGRAM OPTION

OPTION DEFINITION

The Ohio I/M Advisory Group has selected an I/M program for the state that will incorporate the following characteristics:

- Organizational Approach: System owned and operated by a private contractor.
- Geographic Coverage: Statewide.
- Test Type: Loaded mode test based on the Clayton Key Mode procedure, with emission measurements taken at three different engine speeds including idle, but pass-fail criteria based upon idle mode results only.
- Frequency of Inspection: Annual.
- Enforcement: Tied into motor vehicle registration procedures such that a vehicle failing inspection will not be allowed to register.
- Program Administration: Ohio Environmental Protection Agency, with assistance from the Ohio Department of Highway Safety.
- Stringency: 20 percent of the tested vehicle population will fail and need maintenance.
- Vehicles included in program:
  - all light-duty vehicles (passenger cars)
  - light-duty trucks weighing less than 8,500 lb GVW
  - farm trucks
  - diesel-powered vehicles weighing less than 8,500 lb GVW

- Vehicles exempt from inspection

  - buses and trucks weighing over 8,500 lbs GVW.

The U.S. Environmental Protection Agency requires that all I/M programs provide for the inspection of all light duty vehicles. These minimum program requirements do not include heavy duty trucks and buses. Although Ohio would reduce total emission from heavy duty gas and trucks, preliminary findings indicate that including inspection of all heavy duty trucks in the centralized lanes is not a cost effective approach. Gasoline driven heavy duty trucks emit carbon monoxide and hydrocarbons as do the gasoline light duty cars and trucks whereas, the significant diesel emissions are particulates and sulfur dioxide. Currently, U.S. EPA does not have standards for particulates, nor for sulfur dioxides from diesel engines. CO and Hc emissions from diesel are insignificant. Although there are about four times as many gasoline as diesel heavy-duty trucks in Ohio, there are more miles driven by diesel heavy trucks. Of the vehicle-miles traveled in Ohio, travel by all heavy-duty trucks constitute only about 8 percent. Yet, of the total motor vehicle emissions, heavy-duty trucks emission do constitute about one quarter.

Some of the problems in inspecting heavy trucks in centralized lanes concern the expense, time, and danger. The testing equipment includes heavy duty double dynamometers and expensive emission test equipment for diesel emissions. Test time is at least twice as long as for light duty vehicles and in light of the danger of the trucks slipping off the dynamometer while running at high speed, the vehicle must be chained down.

A more cost effective approach appears at this time to be a fleet maintenance program. In view of the rising cost of fuel and the large number of miles traveled by trucks it is in the best interest of fleet owners to maintaining their vehicles in good repair. Keeping their trucks well-tuned saves significant cost in terms of fuel savings and long term maintenance. Better maintenance translates to reduced emissions. Preliminary results from Arizona's I/M program show low failure rates for diesel heavy duty trucks. This supports the basic idea that truck owners already have an important vested interest in good maintenance practices.

  - motorcycles and motorized bicycles

These vehicles are a very small fraction of the total vehicle population. Inspection would require special equipment and would bring significant benefits for the added costs.

  - off the road vehicles not used in public highways

These vehicles are largely recreation vehicles which contribute a very small fraction of the air pollution and are largely used in rural areas.

  - racing cars used solely for exhibition purposes and not in public highways

Racing cars do not have emission control equipment and do not contribute significantly to air pollution. These are the vehicles only used in bonafide races at race tracks.

- certified research vehicles

Research vehicles may not be designed to be able to pass emission tests. Such a requirement might prevent the ability to conduct important research on various aspects of automotive engineering including emissions controls. Such vehicles constitute a very small fraction of total emissions.

- permanent 4-wheel drive vehicles

4-wheel drive vehicles could not be tested on a dynamometer and the very small vehicle population does not justify the cost of acquiring special test equipment.

- certified "historic" (antique) vehicles

Antique cars constitute a very small fraction of the total vehicle population and they would be unable to pass the emission test standards.

- Upon transfer of title, all vehicles included in the program must be reinspected.

- A certificate of compliance with state emission standards will be valid for 90 days to allow sufficient time for motorists to take the emissions test and if necessary have repairs made.

EMISSIONS INSPECTION SCENARIO

In order to illustrate how the I/M program will work and where some of the adjunctive programs tie in, the following description of the test procedure is offered. Figure 2 describes this process.

The requirement for an emissions inspection in each instance will be related to the annual registration procedure; that is, emissions inspections will be required during the period when registration renewals are due. To initiate the registration renewal process, the Bureau of Motor Vehicles within the Department of Highway Safety will mail out registration renewal forms to all vehicle owners. Mailings will be staggered such that approximately one-twelfth of the total registrations are processed each month (slightly lower in winter months). From information contained in the registration renewal package, as well as media advertising carried out by the OEPA's Public Relations effort, motorists must decide whether or not their vehicles are subject to emissions inspection. If the vehicle is exempt from emissions inspection the owner either mails his registration form or takes it in person to the Deputy Registrar where it is processed and the registration process is completed.

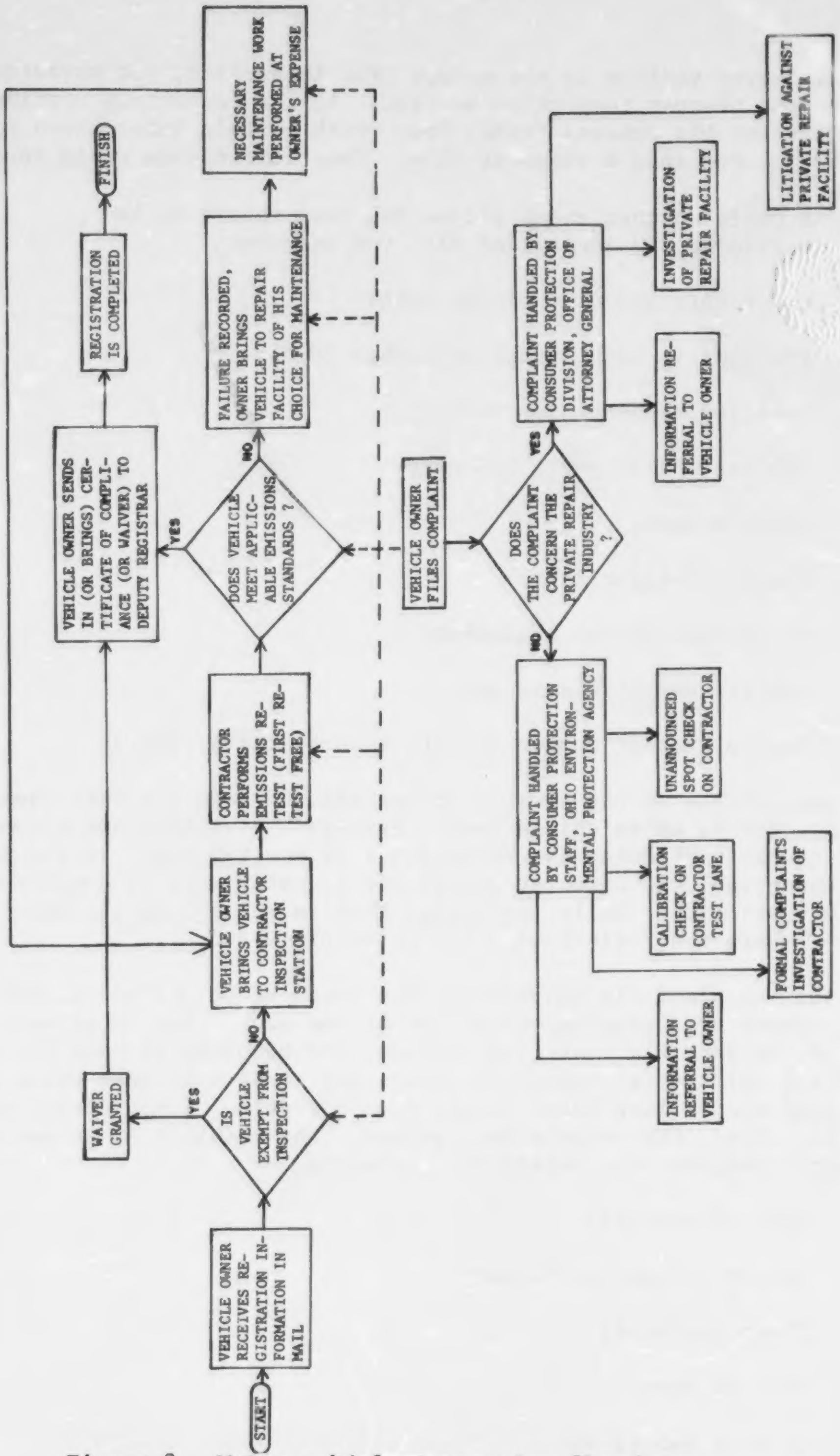
START
VEHICLE OWNER RECEIVES REGISTRATION INFORMATION IN MAIL
IS VEHICLE EXEMPT FROM INSPECTION
YES
NO
WAIVER GRANTED
VEHICLE OWNER BRINGS VEHICLE TO CONTRACTOR INSPECTION STATION
CONTRACTOR PERFORMS EMISSIONS RE-TEST (FIRST RE-TEST FREE)
DOES VEHICLE MEET APPLICABLE EMISSIONS STANDARDS ?
YES
NO
VEHICLE OWNER SENDS IN (OR BRINGS) CERTIFICATE OF COMPLIANCE (OR WAIVER) TO DEPUTY REGISTRAR
REGISTRATION IS COMPLETED
FINISH
FAILURE RECORDED, OWNER BRINGS VEHICLE TO REPAIR FACILITY OF HIS CHOICE FOR MAINTENANCE
NECESSARY MAINTENANCE WORK PERFORMED AT OWNER'S EXPENSE
VEHICLE OWNER FILES COMPLAINT
DOES THE COMPLAINT CONCERN THE PRIVATE REPAIR INDUSTRY ?
NO
YES
COMPLAINT HANDLED BY CONSUMER PROTECTION STAFF, OHIO ENVIRONMENTAL PROTECTION AGENCY
UNANNOUNCED SPOT CHECK ON CONTRACTOR
CALIBRATION CHECK ON CONTRACTOR TEST LANE
FORMAL COMPLAINTS INVESTIGATION OF CONTRACTOR
INFORMATION REFERRAL TO VEHICLE OWNER
COMPLAINT HANDLED BY CONSUMER PROTECTION DIVISION, OFFICE OF ATTORNEY GENERAL
INFORMATION REFERRAL TO VEHICLE OWNER
INVESTIGATION OF PRIVATE REPAIR FACILITY
LITIGATION AGAINST PRIVATE REPAIR FACILITY

Figure 2. Motor vehicle inspection flowchart.

If his motor vehicle is not exempt from inspection, the motorist brings his vehicle to the nearest inspection station. At the inspection station, the motorist will present his renewal forms, from which certain information will be collected and entered into a computer file. This information would include:

1. A serial number which allows the test record to be retrieved and identified with the computer;
2. Exact date and time of the test;
3. The vehicle identification number (VIN);
4. Vehicles registration number;
5. Vehicle model, year, and make;
6. Owner's name;
7. Engine configuration;
8. Emissions control equipment;
9. Vehicle weight class; and
10. Test or retest number (first, second, third, etc.).

If the vehicle is not exempt, it proceeds through the test lane, where it is subjected to an emissions test. Pass-fail critieria are automatically adjusted to the particular characteristics of the vehicle. If the vehicle passes inspection, the computer prints out a certificate of compliance, which the owner either mails (or brings them in person) to the Deputy Registrar, where the registration forms are processed.

If the vehicle fails inspection, the computer prints out a form stating which standards are being exceeded, and by how much. The owner will be advised of the probable cause for failure, and required to have the vehicle repaired and reinspected within 90 days. The owner will then bring the vehicle (and the failure form) to the repair station of his choice or repair it himself. Then, the vehicle is repaired. The mechanic or person doing the repairs completes the repair form, stating:

1. Date of repairs;
2. Repair actions performed;
3. Parts replaced;
4. Cost of parts;
5. Cost of labor; and
6. Name and address of repair facility or person during the repairs.

The vehicle owner then brings the completed form and the vehicle back to a contractor test facility. There, the vehicle undergoes a test procedure similar to that described previously, except that no test fee is charged. If it now meets emissions standards, a certificate of compliance is printed, and the owner completes the registration process as described above.

If the vehicle fails the first retest, the vehicle owner is obliged to go through the repair and reinspection cycle once again. However, 80 to 90 percent of the vehicles pass the first retest. Generally, there is a fee for the second retest, but usually it is less than the initial test fee.

Should a motorist at any point in the above-described process have a complaint concerning either the inspection or the maintenance phase, he may register the complaint at one of two separate consumer protection agencies by calling a toll-free "hot line" telephone number. Program public information will be designed such that motorists with complaints will be advised as to which of the two numbers is appropriate under the circumstances. If the complaint concerns the inspection process or any action on the part of the contractor, it will be referred to the Consumer Protection function within the Ohio Environmental Protection Agency. This activity may be handled by the Division of Environmental Information within OEPA. If the complaint concerns the maintenance phase or any action on the part of the private automotive repair industry, it will be referred to the Consumer Protection Division of the Ohio Attorney General's Office.

Complaints answered by the OEPA can be handled in a variety of different ways. If the complaint is due to lack of information, the motorist could be referred to the Public Information Center of OEPA, which will then provide the motorist with more information concerning the program and its methods. If the complaint concerns actions on the part of the contractor or questions the accuracy of the contractor's equipment, the OEPA could have a mobile calibration official visit the test lane in question and check the calibration of its emissions analysis equipment, or have a complaints investigator conduct either an unannounced spot check or a formal investigation of test lane or personnel question.

If the complaint is handled by the Attorney General's Office, the procedure will be somewhat different. When the consumer contacts the hotline operator, he is sent a complaint form to fill out and return. Once the form is received, a staff member then calls the automobile dealer or repair facility in question and tries to work out the problem. If the problem cannot be resolved to the satisfaction of both parties, a member of the Consumer Protection Division's investigative staff is called on. He will then visit the facility and attempt to resolve the grievance. If a violation of law is discovered, the case is turned over to a staff lawyer for prosecution; action for restitution or damages may then be initiated.

SECTION 4

I/M PROGRAM BENEFITS

INTRODUCTION

Concern for controlling automotive emissions stems from the fact that automobile traffic is responsible for approximately 75 percent of all urban carbon monoxide (CO) emissions, 50 percent of hydrocarbon (HC) emissions, and 50 percent of the oxides of nitrogen (NO_x) emissions in Ohio. EPA data indicate that automobile transportation is responsible for as much as 14 to 23 percent of total air pollution costs. A study by the National Academy of Science estimated annual societal costs for this pollution (in 1969) to range from $2.2 to $5.7 billion.[1] When these costs are subsequently adjusted to account for todays inflation rates, these costs rise to $3.3 to $8.6 billion. Furthermore, a 1978 study by the National Highway Traffic Safety Administration indicates that "the prorated societal cost of air pollution caused by automobiles would be equivalent to from $24.30 to $64.30 per vehicle."[1] This same study also states that "it is conceivable that national inspection and mandatory maintenance would reduce societal cost of pollution $1.3 to $3.4 billion annually."[1]

Besides these economic benefits and the benefit of decreased emissions seen from I/M implementation, other important benefits may accrue. These include an improvement in fuel economy, which in turn has a positive effect on gasoline consumption. Benefits have also been indicated for fleets that undergo their own special maintenance programs.

EMISSIONS REDUCTIONS

Emission reduction is the primary benefit to be derived from I/M programs. Although new vehicles are required to meet certain U.S. EPA specifications for emissions, it has been shown that emission rates for in-use vehicles deteriorate significantly unless adequate maintenance is performed. I/M has been suggested as an effective means for ensuring that the necessary routine maintenance is performed periodically, thus resulting in a significant decrease in emissions generated by the motor vehicle population.

Various levels of reductions in emissions have been noted in ongoing I/M programs. The actual reduction varies with stringency factors, climate, and other considerations. Hamilton Test Systems, under contract to the State of Arizona, noted in a 1978 report[2] that of those vehicles undergoing inspection and subsequent maintenance in the Arizona I/M program, 25 percent reduction in idle CO emissions and 41 percent reduction in idle HC emissions were shown compared to those tested in 1976 (Pre-I/M). Hamilton Test Systems claims that this program is reducing by about 250 tons daily, the amount of CO and HC emitted into the atmosphere in the Arizona counties covered by I/M, as well as saving motorists an estimated 30 million gallons of gasoline annually.[3]

Analyses performed by other state and federal agencies[4] show similar results.

Projected Emission Reductions

Motor vehicle emission inventories for both CO and HC were developed for the State of Ohio using EPA's MOBILE1 computer routine. Input data regarding vehicle-miles of travel (VMT) by vehicle type, roadway functional class, and speed were provided by the Ohio Department of Transportation and the Ohio, Kentucky, and Indiana Council of Goverments. It should be noted that the emission inventories developed for use here are of a preliminary nature and may be different from the rather detailed inventories currently being developed by the state for use in the upcoming State Implementation Plan revision. That the inventories presented here are of a preliminary nature does not diminish their usefulness significantly since the intent is to indicate relative emissions burden with and without an I/M program, rather than define the absolute magnitude of emissions produced. A detailed description of the methodology used in deriving the inventories is provided in Appendix A.

Statewide inventories were prepared for each year beginning with 1983 through 1987 for the entire state. Average daily emissions generated by light-duty vehicles (cars and trucks) and by all vehicles were defined for two scenarios. The first scenario reflected the vehicle population emission characteristics in the absence of an I/M program, while the second scenario reflected the compounded effects of an I/M program beginning in January 1982 on emissions during each year. Comparison of the emission totals for both the total vehicle population, and the individual vehicle classes affected by I/M indicate the impact that I/M can be expected to have. Tables 8 through 11 provide a summary by road type of daily CO and HC emissions, respectively, during the years 1983 through 1987, both with and without the I/M program (as defined in Section 2), for both the total vehicle population and for LDV's and LDT's only. Table 8 shows the statewide tabulation for CO for the years 1982 through 1987 for light-duty vehicles while Table 9 shows the same data with regard to HC emissions. Tables 10 and 11 are similar to 8 and 9 except that emissions from the entire vehicle population are shown. Of particular interest is the reduction achievable by 1987 for the LDT and LDV population. As stated in the Federal guidelines for I/M programs in Appendix C of this report, U.S. EPA requires that the program produce at least a 25 percent reduction in emissions in 1987 from vehicles included in the program (LDV's and LDT's) compared to the emissions that would be produced by these same vehicles in 1987 without I/M. The last column in Tables 8 and 9 indicate that the proposed I/M program will, on the average for all counties, achieve a reduction of 46 percent and 29 percent for CO and HC, respectively, indicating that the program configuration is more than adequate to meet EPA's minimum standards. The reductions by year are shown graphically for CO and HC in Figures 3 and 4, respectively. A detailed emission inventory of the 18 most urbanized counties was also prepared. It is included in Appendix E of this report.

Table 8. PROJECTED CARBON MONOXIDE EMISSIONS (kg/day) AND PERCENT REDUCTIONS FROM I/M PROGRAM AT 20 PERCENT STRINGENCY FROM 1982 TO 1987 FOR THE STATE OF OHIO, ACHIEVABLE FOR LDV_1, LDT_1, AND LDT_2 ONLY

Roadway classification	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Federal-Aid Interstate Rural (Arterial)	326,173	298,808	240,520	20	273,782	196,736	28	252,375	164,369	35	233,478	134,944	42	218,043	111,092	49
Federal-Aid Interstate Urban (Arterial)	452,851	412,149	331,475	20	374,300	269,775	28	341,254	224,276	34	311,363	182,816	41	286,214	148,991	48
Federal-Aid Other Primary Rural (Arterial)	440,744	395,723	321,189	19	354,993	258,876	27	319,926	212,825	33	288,998	172,245	40	263,491	140,319	47
Federal-Aid Other Primary Urban (Arterial)	308,589	277,145	224,516	19	248,193	180,934	27	222,855	148,631	33	200,078	119,921	40	180,982	97,121	46
Federal-Aid Urban (Arterial)	696,410	633,127	518,324	18	575,267	424,260	26	525,276	353,680	33	481,116	291,246	39	445,132	242,601	45
Federal-Aid Urban (Collector)	221,567	199,619	161,807	19	179,576	130,687	27	162,196	107,605	34	146,719	87,135	41	133,879	70,943	47
Federal-Aid Secondary Rural (Collector)	453,161	412,211	337,756	18	374,838	276,615	26	342,592	230,659	33	314,031	190,004	39	290,800	158,210	46
Non-Federal-Aid Rural (Collector)	277,652	251,908	206,088	18	228,243	168,446	26	207,670	140,238	32	189,452	115,267	39	176,523	95,844	45
Non-Federal-Aid Rural (Local)	1,076,347	925,642	757,281	18	833,744	615,314	26	754,188	509,294	32	683,942	416,129	39	626,366	343,985	45
Non-Federal-Aid Urban (Local)	408,887	369,749	302,963	18	334,260	246,670	26	303,705	204,478	33	276,736	167,440	39	254,760	138,603	46
Total	4,612,381	4,176,081	3,401,919	19	3,777,196	2,768,313	27	3,432,037	2,296,053	33	3,125,913	1,877,147	40	2,874,190	1,547,709	46

Table 9. PROJECTED HYDROCARBON EMISSIONS (kg/day) AND PERCENT REDUCTIONS FROM I/M PROGRAM AT 20 PERCENT STRINGENCY FROM 1982 TO 1987 FOR THE STATE OF OHIO, ACHIEVABLE FOR LDV_1, LDT_1, AND LDT_2 ONLY*

Roadway classification	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Federal-Aid Interstate Rural (Arterial)	42,780	37,397	35,348	5	33,132	30,029	9	29,452	25,084	15	26,469	20,783	21	24,286	17,438	28
Federal-Aid Interstate Urban (Arterial)	62,712	54,605	51,918	5	47,529	43,646	8	41,594	36,318	13	36,687	29,972	18	32,985	25,027	24
Federal-Aid Other Primary Rural (Arterial)	56,572	48,737	46,066	5	42,063	38,158	9	36,555	31,274	14	32,062	25,419	21	28,643	20,907	27
Federal-Aid Other Primary Urban (Arterial)	41,718	35,766	33,956	5	30,671	28,075	8	26,441	22,902	13	22,972	18,657	19	20,316	15,316	25
Federal-Aid Urban (Arterial)	74,302	65,444	61,121	7	57,800	51,360	11	51,642	42,677	17	46,533	35,130	25	42,631	29,273	31
Federal-Aid Urban (Collector)	28,617	24,634	23,319	5	21,238	19,317	9	18,434	15,834	14	16,142	12,871	20	14,399	10,588	26
Federal-Aid Secondary Rural (Collector)	54,239	47,451	44,636	6	41,647	37,405	10	36,839	31,017	16	32,898	25,507	22	29,895	21,228	29
Non-Federal-Aid Rural (Collector)	29,051	25,650	23,900	7	22,741	20,110	12	20,341	16,727	18	18,373	13,775	25	16,868	11,482	32
Non-Federal-Aid Rural (Local)	107,392	94,253	87,826	7	83,073	73,463	12	73,872	60,751	18	66,333	49,732	25	60,343	41,212	32
Non-Federal-Aid Urban (Local)	46,939	42,563	40,038	6	37,139	33,355	10	32,657	27,496	16	28,992	22,476	22	26,190	18,596	29
Total	546,322	476,698	448,322	6	417,113	374,918	10	367,827	310,160	16	327,461	254,322	22	296,736	211,067	29

*Nonmethane HC only.

Table 10. PROJECTED CARBON MONOXIDE EMISSIONS (kg/day) AND PERCENT REDUCTIONS FROM I/M PROGRAM AT 20 PERCENT STRINGENCY FROM 1982 TO 1987 FOR THE STATE OF OHIO FOR ALL VEHICLES

Roadway classification	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Federal-Aid Interstate Rural (Arterial)	529,548	504,465	446,019	12	474,290	397,064	16	446,878	358,694	20	421,377	322,669	23	402,269	295,151	27
Federal-Aid Interstate Urban (Arterial)	780,742	743,340	662,441	11	696,934	592,154	15	653,977	536,744	18	613,212	484,420	21	581,893	444,435	24
Federal-Aid Other Primary Rural (Arterial)	614,986	568,412	493,682	13	519,865	423,532	19	476,533	369,225	23	437,217	320,265	27	405,908	282,549	30
Federal-Aid Other Primary Urban (Arterial)	449,590	416,186	363,423	13	380,371	312,963	18	347,888	273,519	21	317,877	237,584	25	293,628	209,638	29
Federal-Aid Urban (Arterial)	806,948	741,805	626,735	16	677,927	526,623	22	621,676	449,792	28	571,332	381,186	33	530,984	328,190	38
Federal-Aid Urban (Collector)	313,105	289,966	252,058	13	265,520	216,525	18	263,547	188,854	22	223,418	163,737	27	207,279	144,251	30
Federal-Aid Secondary Rural (Collector)	53[illegible],851	490,069	415,439	15	448,628	350,213	22	412,071	299,952	27	379,153	234,948	33	352,874	220,115	38
Non-Federal-Aid Rural (Collector)	323,344	296,641	250,715	15	270,397	210,481	22	247,169	179,620	27	226,357	152,062	33	209,584	130,798	38
Non-Federal-Aid Rural (Local)	1,195,242	1,090,013	921,256	15	987,723	768,857	22	897,628	652,314	27	817,171	548,957	33	752,199	469,437	38
Non-Federal-Aid Urban (Local)	479,888	439,586	372,644	15	400,063	312,301	22	365,298	265,905	27	334,124	224,670	33	309,141	192,835	38
Total	6,025,244	5,580,483	4,804,412	14	5,121,718	4,110,713	20	4,712,665	3,574,619	24	4,341,238	3,090,498	29	4,045,759	2,717,399	33

Table 11. PROJECTED HYDROCARBON EMISSIONS (kg/day) AND PERCENT REDUCTIONS FROM I/M PROGRAM AT 20 PERCENT STRINGENCY FROM 1982 TO 1987 FOR THE STATE OF OHIO FOR ALL VEHICLES*

Roadway classification	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Federal-Aid Interstate Rural (Arterial)	57,709	51,499	49,429	4	45,779	42,651	7	40,886	36,492	11	36,901	31,190	15	33,990	27,119	20
Federal-Aid Interstate Urban (Arterial)	86,453	76,694	73,978	4	67,614	63,697	6	59,736	54,424	9	53,226	46,476	13	48,354	40,363	17
Federal-Aid Other Primary Rural (Arterial)	70,816	61,766	59,067	4	53,704	49,768	7	46,923	41,612	11	41,381	34,710	16	37,190	29,428	21
Federal-Aid Other Primary Urban (Arterial)	52,305	45,377	43,549	4	39,196	36,580	6	33,958	30,478	10	29,660	25,327	15	26,388	21,369	19
Federal-Aid Urban (Arterial)	83,498	73,900	69,540	6	65,475	58,912	10	58,471	49,465	15	52,746	41,302	22	48,398	35,001	28
Federal-Aid Urban (Collector)	35,578	30,960	29,632	4	26,851	24,914	7	23,387	20,773	11	20,554	17,271	16	18,408	14,584	21
Federal-Aid Secondary Rural (Collector)	60,026	52,691	49,852	5	46,272	42,003	9	40,911	35,063	14	36,319	29,101	20	33,173	24,483	26
Non-Federal-Aid Rural (Collector)	33,033	29,331	27,567	6	26,069	23,421	10	23,355	19,725	16	21,137	16,522	22	19,453	14,032	28
Non-Federal-Aid Rural (Local)	122,107	107,779	101,296	6	95,228	85,555	10	84,817	71,634	16	76,308	59,647	22	69,820	50,434	28
Non-Federal-Aid Urban (Local)	54,162	47,263	44,716	5	41,263	37,456	9	36,267	31,083	14	32,182	25,644	20	29,062	21,448	26
Total	655,687	577,260	548,626	5	507,451	464,957	8	448,711	390,749	13	400,614	327,190	18	364,236	278,281	24

[*] Nonmethane HC only.

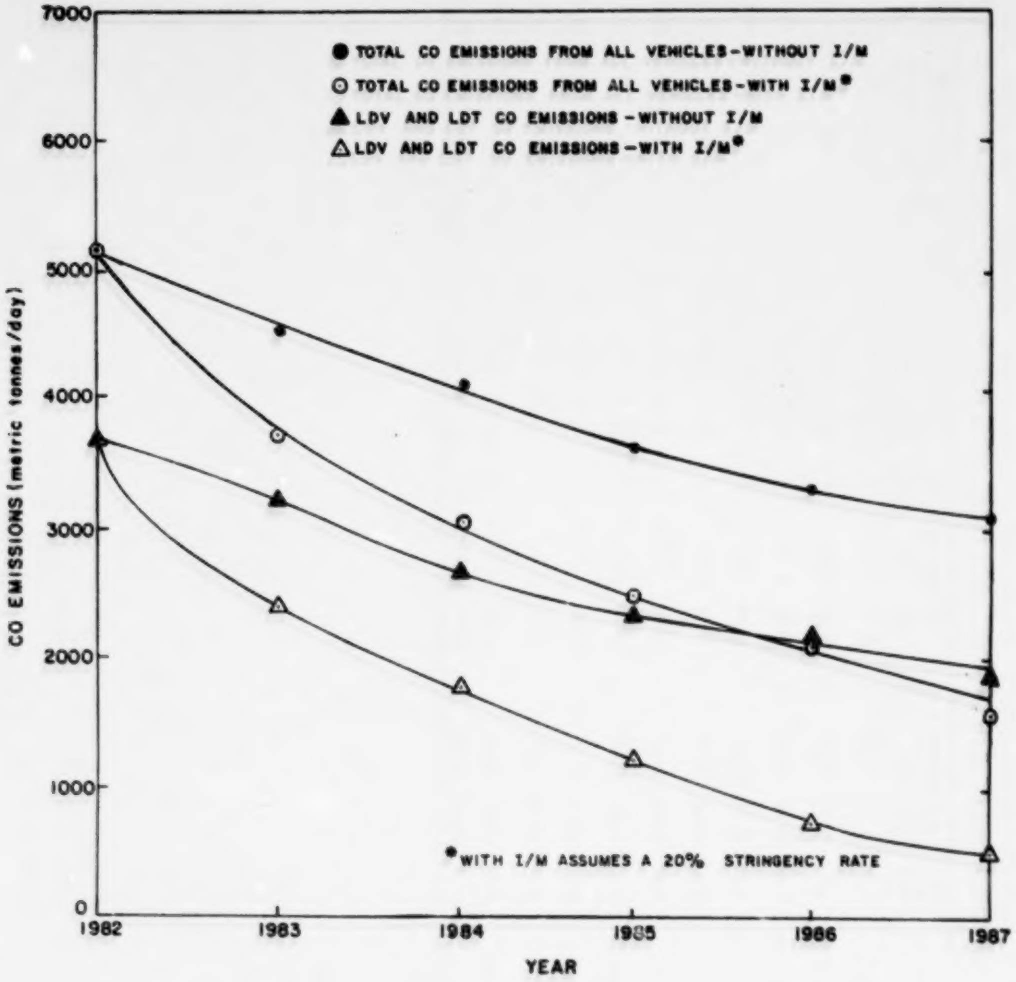

Figure 3. Daily CO emissions by year for LDV's and LDT's only, and for all vehicles with and without I/M — 1982 through 1987.

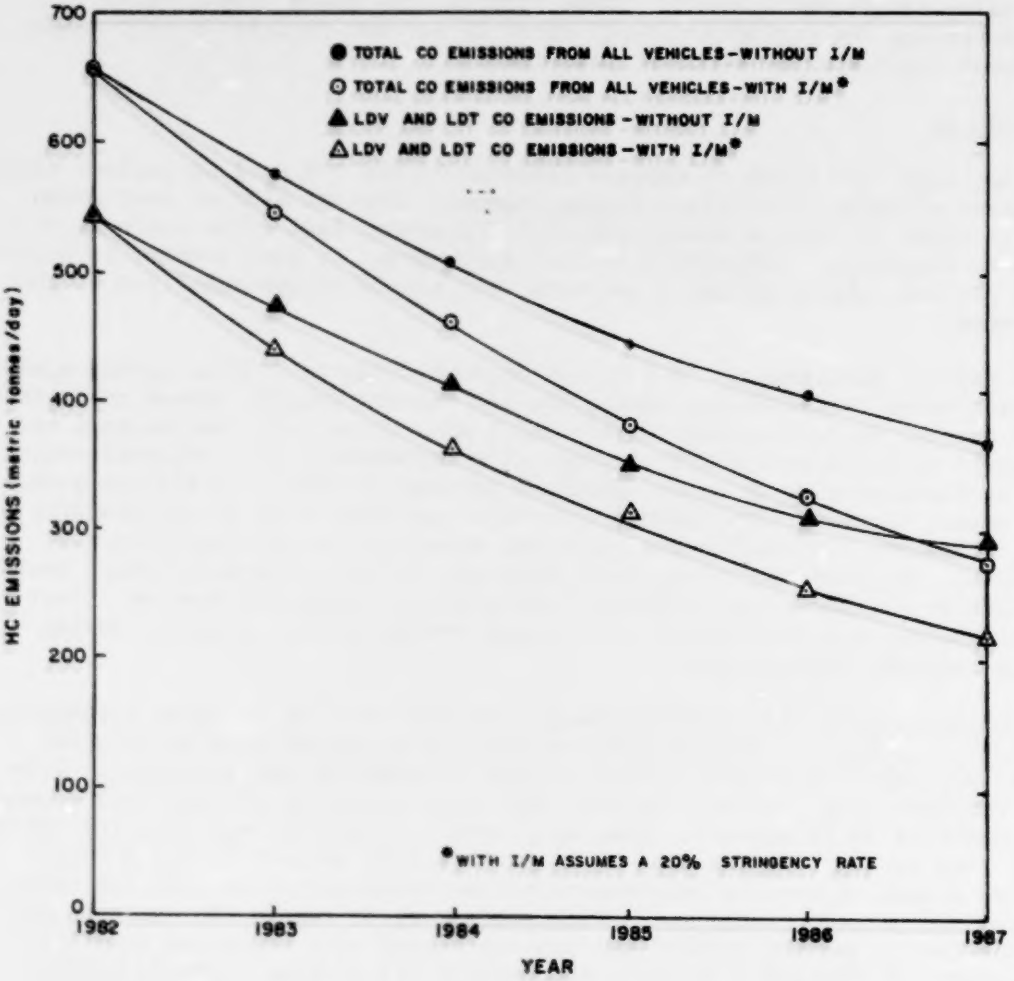

Figure 4. Daily HC emissions by year for LDV's and LDT's only and for all vehicles with and without I/M — 1982 through 1987.

An analysis of the effects of varying the stringency factor was also conducted, again using MOBILE1. Average daily CO and HC emissions were computed for 1983 and 1987 using the I/M program scenario discussed in Section 3, except that stringency factors of 30 and 40 percent were substituted for the 20 percent rate. A summary of the impact that the different stringency factors have on CO and HC is presented in Table 11a; these data are also displayed graphically in Figures 5 and 6. These figures show quite dramatically that increasing the stringency level above 20 percent results in very slight additional reductions in CO or HC emissions.

Fuel Economy

Typically, the types of repairs required by the I/M program include either carburetor adjustments or minor engine tuneups. Several studies have shown that the types of repairs associated with I/M affect fuel consumption as well as reduce emissions. Although a general improvement in fuel economy is reported in the studies, there remains a question with regard to the magnitude of the improvement.

A report[1] published in 1978 by the National Highway Traffic Safety Administration noted that vehicles undergoing I/M related repairs showed an increase of 4.7 percent in fuel economy. This study also noted that fuel savings nationwide could be projected if I/M programs were implemented on a national scale; these projections show an annual gasoline savings of about 1.8 billion gallons. It is noted, however, that these projections are based only on one specific study, therefore the results and conclusions may not be applicable in all instances. The important point here, however, is that relatively minor problems such as a maladjusted carburetor or ignition timing can have an effect on fuel economy and these types of problems become readily apparent during routine emission inspections.

Champion Spark Plug Company, along with aid from the American Automobile Association, conducted vehicle tests nationwide to gather data on motorist maintenance habits and their effect on fuel consumption and emissions. This study concluded that, after a tuneup, test cars showed an average fuel economy improvement of 11.36 percent. Even as a result of simply replacing the spark plugs, fuel consumption was seen to improve by 3.68 percent.[5] The survey revealed a lack of vehicle maintenance by the motoring public. Of the cars surveyed, 79 percent needed some maintenance work to regain the optimum performance level, and the type of maintenance needed most often was ignition and carburetion service. To quote the report, the program "clearly pointed out the advantages gained by new plugs alone or complete engine tuneup in providing better mileage, lower emissions, and better overall driving performance."[5] Of interest when considering I/M program vehicle coverage, is the fact that the oldest cars in the study (pre-1968) showed the greatest improvement (in miles per gallon) in fuel economy of all year groups.

Another fuel economy improvement study was undertaken by Jerome Panzer of Exxon Research and Engineering Company.[6] Using a 50 percent rejection rate, a pre-1975 vehicle population, and subsequent tuneups for failed vehicles, the average gain in fuel economy between annual inspections for study

TABLE 11a. EFFECT OF VARYING THE STRINGENCY FACTOR ON CO AND HC EMISSIONS REDUCTION POTENTIAL

Pollutant	Year	LDV's and LDT's only daily emissions* in kg/day and (percent reduction)†				All vehicles daily emissions* in kg/day and (percent reduction)†			
		Without I/M	I/M with 20% stringency	I/M with 30% stringency	I/M with 40% stringency	Without I/M	I/M with 20% stringency	I/M with 30% stringency	I/M with 40% stringency
Carbon monoxide	1983	4,176,081	3,401,919 (19%)	3,252,272 (22%)	3,173,262 (24%)	5,580,483	4,804,412 (14%)	4,654,283 (17%)	4,575,035 (18%)
	1987	2,874,190	1,547,709 (46%)	1,417,426 (50%)	1,341,761 (53%)	4,045,759	2,717,399 (33%)	2,586,797 (36%)	2,510,944 (38%)
Hydrocarbons	1983	476,698	448,322 (6%)	442,934 (7%)	440,128 (8%)	577,260	548,626 (5%)	543,152 (6%)	540,317 (6%)
	1987	296,756	211,067 (29%)	201,841 (32%)	196,032 (34%)	364,236	278,281 (24%)	268,972 (26%)	263,120 (28%)

*Total daily emissions for the entire State of Ohio.

†Percent of analysis year emissions without I/M.

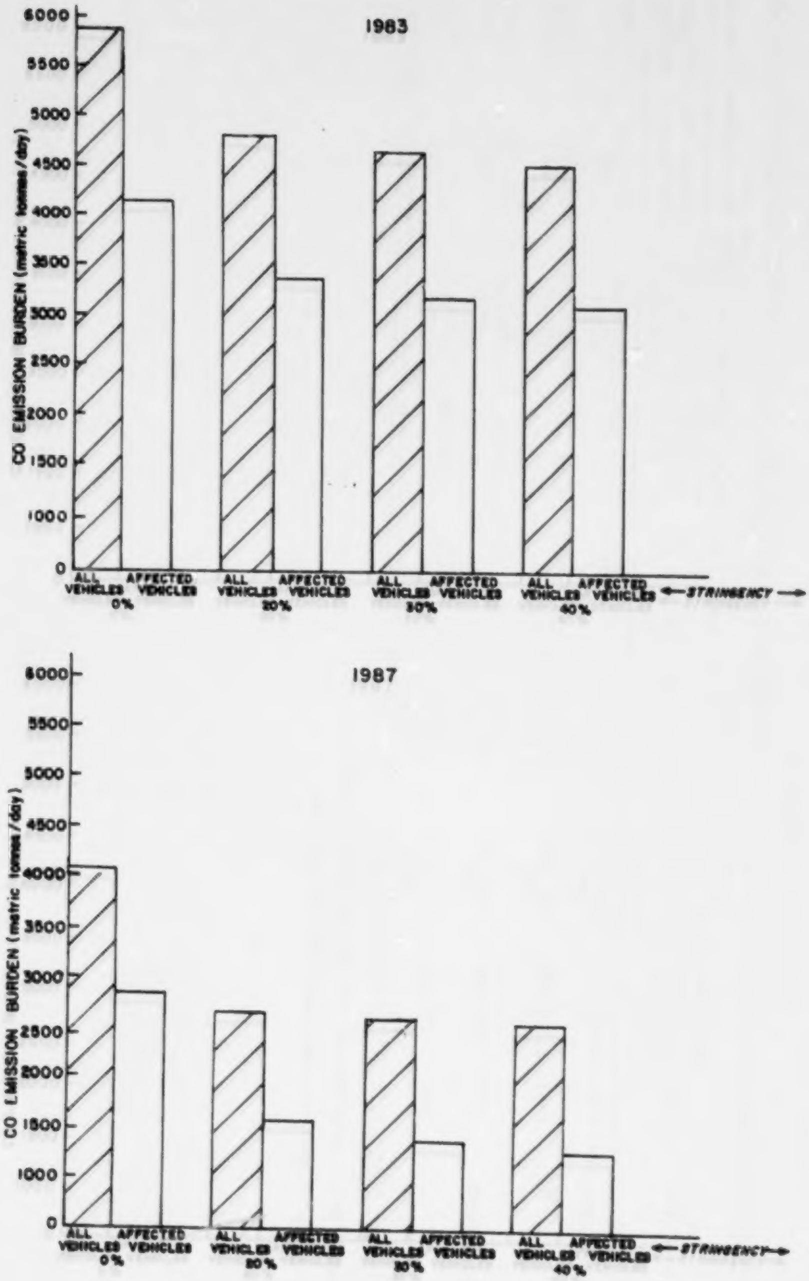

Figure 5. Effect of varying the stringency level on CO emissions for LDV's and LDT's only, and for all vehicles for the years 1983 and 1987.

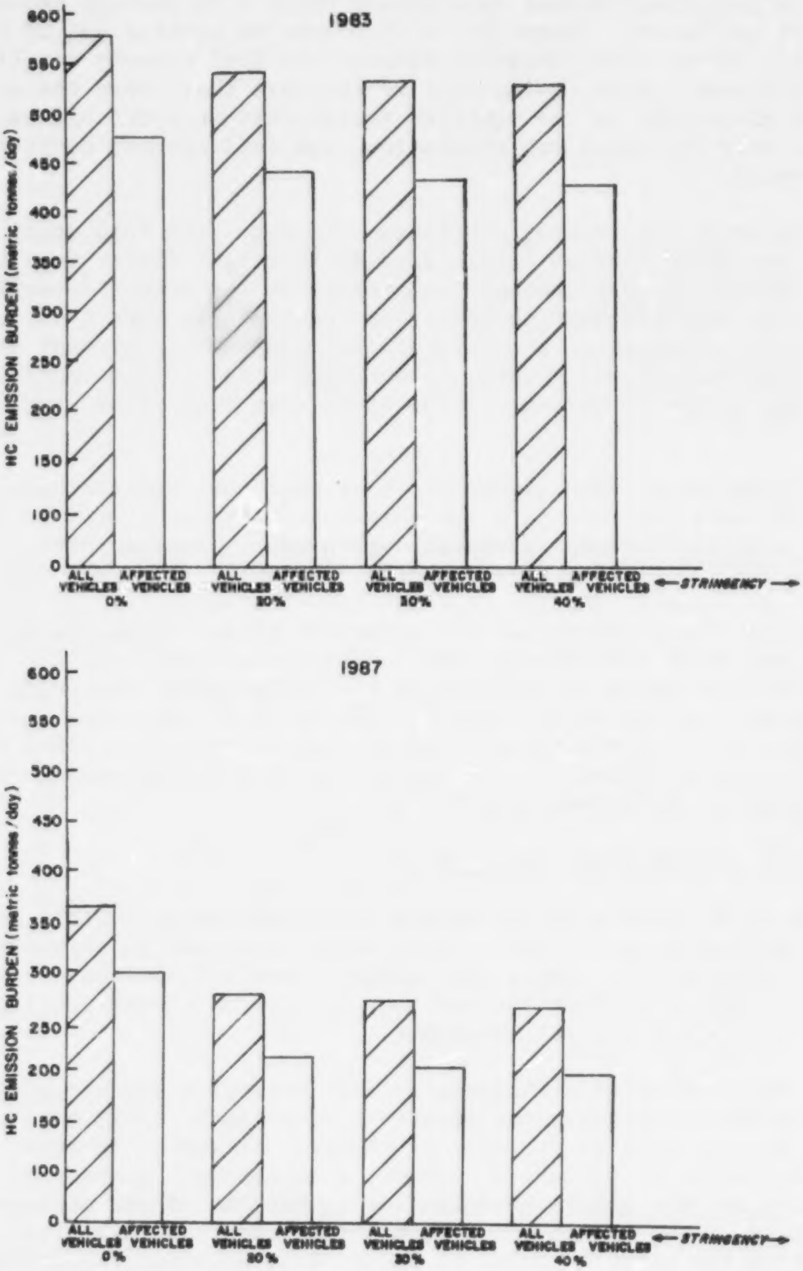

Figure 6. Effect of varying the stringency level on HC emissions for LDV's and LDT's only, and for all vehicles for the years 1983 and 1987.

vehicles was about 7.5 percent. This figure has been adjusted to account for estimated deterioration; without considering this, a 13 percent immediate improvement is indicated. Panzer found that repairs carried out to correct only emissions produce about three-fourths of the fuel economy benefit acheived by a complete tuneup. Also of interest is the fact that, when the effect of repairing the 50 percent of the vehicles tested that were the highest emitters is spread out over the total car population, the fuel economy drops to an estimated 2 percent.

There are other interesting conclusions to note from this study. For instance, it was found that as little as a 40 lb weight factor in a car has a detectable effect on fuel consumption. Also, at the lowest rejection rates, the malfunctions repaired were those having the greatest impact on fuel economy (e.g., misfires). Therefore, the rate of fuel economy improvement diminishes as the rejection rate rises. There was no significant fuel economy change noted in tuning up the 50 percent of the study cars that passed the emissions tests.

For the purposes of this study, it is assumed that the fuel economy improvement for vehicles that fail the emissions test and therefore undergo maintenance, will be 7 percent averaged over a year. Applying this to the projected statewide vehicle population of 8,251,000 in 1987, the failure rate chosen — 20 percent, and the relative travel distribution by various model year vehicles and EPA requirements for miles per gallon standards for various years, it is estimated that during 1987, approximately 44.6 million gallons of gasoline would be saved as a result of the I/M program. Assuming further that the cost of a gallon of gasoline in 1987 is $0.80, the fuel cost savings associated with the 44.6 million gallons of fuel conserved is $35.7 million. A detailed discussion concerning the derivation of the fuel savings associated with the program is presented in Appendix B.

Impact on Vehicle Performance and Life

The effects of inspection and maintenance programs on vehicle performance and life are currently under study. Preliminary analyses in this area have focused on various vehicle fleets and indicate that I/M does have a positive effect on both vehicle performance and vehicle life, although specific, quantitative statistics are not yet available.

Some of the more notable findings to date regarding vehicle performance come from programs established for fleets of vehicles by their owners. One such program may be found in the City of Phoenix, Arizona. In order to reduce on-the-road failures, an extensive preventive maintenance inspection program was implemented for the city's vehicle fleet. Results of the program were closely monitored resulting in the determination that: (1) the fuel consumption rate during the first 6 months of the program decreased approximately 10 percent, much of which was attributed directly to the program; and (2) a significant decrease occurred in the number of vehicles breaking down on the road and requiring towing.

Another example of a fleet which has profited from the institution of an extensive preventive maintenance program is the firm of Mountain Bell of New Mexico. They have noticed not only reductions in maintenance and operating expenses and a safer fleet, but also, reduced vehicle emissions such that their fleet vehicles can now easily meet California clean air standards, even though New Mexico at this time does not require vehicles to meet such standards. Since the program was initiated, the average life expectancy of Mountain Bell's vehicles has been increased by from 1 to 2 years, and the vehicles have had to be replaced less often. In addition, as maintenance and fuel costs have increased over time, Mountain Bell has found their actual dollar expenditures have remained about the same. As the manager of the telephone company's fleet in New Mexico has stated, "the secret is that there are so many side benefits that accrue from attempting to meet clean air standards, you will ultimately save money while satisfying the law."[7]

An aspect of the benefits that has not been adequately studied to date concerns the deterioration of emission characteristics over time subsequent to repairs being performed. Several studies have been performed that indirectly consider the subsequent deterioration of emissions but consistent conclusions regarding the long-term (over a 1-year period, say) effect have not been reached.

Indirect Benefits and Impacts

The improvement in fuel economy that results from an I/M program is an important benefit for vehicle owners. The vehicle owners view the fuel savings as an individual economic issue, whereas the total or aggregate fuel savings is actually an important energy conservation savings as well.

The cost savings that result from the improvement in fuel economy, the better engine performance and increased longevity may not be readily apparent to the individual motorists, although the fleet owners who have good long-term records will be able to perceive these benefits over time. It is important, therefore, that the motoring public be made aware of these benefits.

On the other hand, the obvious costs of repairs for failed vehicles will be be readily apparent to the vehicle owners. The question arises, however, as to how much of these repair costs should be directly attributable to the I/M program. While it is true that a vehicle owner is forced to make a repair if his vehicle does not comply, it is inappropriate to charge the entire cost of mandated repairs to I/M requirements. I/M will cause vehicles to be repaired more completely and frequently than they would be without it. Indeed, this is the purpose of I/M. But a fraction of the repair cost would have been incurred regardless. Estimates of the magnitude of this fraction vary from 25 to 75 percent.

This issue of mandated repairs is central to I/M program externalities. The costs of these repairs are a burden on the vehicle owner. These costs will not be distributed evenly throughout the population. It is safe to assume that older vehicles will generally be owned by individuals at the lower end of the economic spectrum. These vehicles are more likely to require repairs than newer vehicles. If these vehicles fail to meet I/M standards more frequently than newer vehicles, the burden of I/M could fall unevenly on lower income segments of the population. This uneven impact is partially mitigated by establishing exemptions to compliance based on vehicle age and ceilings on the dollar value of mandated repairs.

As the vehicle mix changes over time, this problem will become less severe than it may be now. As older vehicles, those that are costly to maintain to standards, dropout of the vehicle population, they will be replaced by used vehicles. Vehicles included in a mandatory I/M program are likely to be well-maintained. It is possible that this may lower the overall cost of maintaining vehicles throughout their serviceable life.

This trend will be countered to a certain extent because vehicles filtering down via resale will be equipped with various emissions control devices. This equipment has been covered by a 50,000-mile warranty by manufacturers as a result of the Federal 207(b) warranty requirements discussed in consumer protection in Section 6. The useful life of emission control devices covered by warranty is not presently known. Of course, if these devices prove to be as durable as the vehicles in which they are installed, they will not create extra repair costs as these vehicles age. However, should they require replacement after 50,000 miles but prior to the end of a vehicle's life, the cost of doing so will fall on the used car owner who is generally in a lower income category than the initial purchaser. Replacing control devices could become costly. Thus, if these devices do require extensive maintenance to be kept operating correctly after 50,000 miles, I/M may impose a greater financial burden on the used vehicle owner than it will on the public at large.

Establishing an accurate average cost for repairs that are induced by I/M is difficult. General data from existing programs can provide a starting point in contemplating the magnitude of this figure. For California's Riverside Trial Program, the average repair cost for a vehicle failing inspection, including parts, tax and labor was $11.42 when adjusted to remove voluntary repairs made at the time required repairs were performed.[8] This figure applies repair costs for a 40 percent stringency rate over the entire vehicle population tested. Average repair values for California were $27.33 and $32.08 for idle- and loaded-mode testing. In a similar study in Michigan these figures were $23.29 and $36.56.[9]

In these studies, the repair costs directly attributable to I/M may not be accurate. This is for two reasons. One reason, mentioned earlier, is that some of these repairs would have been made anyway, even if the I/M program was not in existence. Second, no accounting is made, nor can it be made with current data, of extra repair costs incurred in anticipation of inspection. It is likely that some vehicles that pass the first time through inspection have attained higher maintenance standards than they would have otherwise in order to avert failure and the inconvenience of traveling to the inspection site a second time for retesting.

The nature of repairs required to meet I/M standards for failed vehicles can help shed light on the burden noncomplying vehicle owners must bear. The Riverside Trial Program found that 66 percent of the diagnosed repair evaluations consisted of an imbalance in the idle air-to-fuel ratio. An additional 18 percent of vehicles failing were diagnosed as experiencing rich carburetion. These problems are neither difficult nor costly to rectify. Thus, the average repair cost figures may be somewhat misleading. Most vehicles requiring service will experience costs lower than the average reported figure. A small portion will have bills considerably in excess of the average reported figure. If these bills fall into waiver regions (either an absolute dollar limit on repair cost or a percentage of vehicle value figure), then assuming an average repair cost for all failed vehicles can overstate the total repair cost burden to vehicle owners; that is, the total cost of required repairs (those that do not exceed cost limit categories) may be less than the total cost of repairs reported by an I/M sequence.

There are other costs to vehicle owners relating to I/M in addition to repair costs and the vehicle inspection fee. Two major costs to consider are time and operating costs experienced traveling to and from inspection sites. Actual operating costs can be calculated fairly accurately. Time costs have a much more subjective nature.

The vehicle miles traveled (VMT) as a result of an I/M program depend on the size of the affected vehicle population, density of that population, siting of inspection stations, and so forth. A fairly reliable total VMT estimate can be used to determine total vehicle operating costs and time spent on those induced VMT. Applying an average emission level to these extra VMT can provide a rough estimate of emissions induced by the implementation of I/M.

An elusive but probably a more significant figure is the time cost of travel to and from, and waiting time at inspection facilities. There are evaluative decisions about the value of time spent traveling, waiting time, and so on that must be resolved before a dollar figure can be computed. The issue is complicated because different people value their time differently and even value different types of time differently (e.g., time spent driving versus time spent waiting at an inspection site). The value an individual places on his time is related to his income level. As income rises, an individual tends to value his time more highly.

Estimating operating and time costs is further complicated because it is difficult to determine what portion of these costs to assign directly to I/M requirements. Many times the trip to an inspection site is combined with other errands and stops. The total costs, time and operating, of such trips should be allocated between the different purposes served by them. It is also difficult to determine how circuitous the I/M stop is. It may require a substantial detour in some cases and none in others.

A potential benefit for the vehicle owner is money saved by utilizing diagnostic information provided by I/M to correct small problems before they become serious. By prompting repairs early on I/M can help eliminate substantial costs to the vehicle owner.

This brief overview of the impacts I/M may have for vehicle owners serves to emphasize the complex nature of program costs and benefits. A qualitative evaluation of them helps assure that they will be considered when implementing I/M.

Impact on the Automotive Repair and Parts Industry

It is safe to state that I/M implementation will result in an increased demand for repair activities and replacement parts. To the extent that I/M induces new repairs that would not have been performed otherwise, the repair industry will directly benefit from the program.

Job creation will be necessary to increase the supply of repair personnel to meet new demand. The ratio of mechanics to vehicles has been declining significantly over the last few decades. In 1950 there were 73 vehicles for every mechanic nationwide. By 1975 this ratio decreased to one mechanic available for every 146 vehicles. This trend cannot continue if I/M becomes a reality. As emissions regulations increase, vehicle complexity will extend repair times for existing components. New subsystems will also be created that will eventually require repair and the demand for mechanic time will increase for each vehicle.

In addition to recruiting and training new mechanics, existing personnel should undergo at least a limited retraining phase to orient them to the purposes and goals of I/M and emissions control. In some cases the needs of I/M are in conflict with maintenance standards now existing that emphasize high engine performance. It is important that the repair industry be aware of the different criteria demanded by I/M so that it may act accordingly.

No matter how responsive the supply of mechanics is to this increase in demand, some lag is inevitable. This should be brief, as new mechanics will be trained and in turn enter the labor pool as the public becomes aware of the implications of I/M. As the supply of repair personnel expands, the consumer will again be able to choose between many repair shops. This will make potential overpricing practices more difficult.

Average repair costs in existing I/M programs vary from $16 to $32 per failed vehicle. At $24 per failed vehicle total revenue would be roughly $42 million for repairs in 1978 dollars. As discussed earlier this figure is very uncertain. Not included would be the repairs done in anticipation of the emission test. However, many motorists already tune their cars regularly and it is dubious to attribute all I/M related repairs to the program as a benefit or a cost.

Jobs in the Private Sector

The implementation of an I/M program in Ohio would result in the creation of roughly 1055 jobs in the private sector. These would be the employees of the contractor chosen by the state to operate the centralized inspection lanes. They include 996 local, 51 regional, and 8 state level jobs. The majority of the positions would be the actual emission station inspectors. There would be 847 station inspectors, at the 57 urban and 45 rural stations. The total annual salaries plus overhead paid for all private contractor employees are 12.8 million for station level personnel and $598 thousand for contractor regional and state level administrative personnel. The salaries for these positions are paid for by the inspection fee.

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SECTION 5

NETWORK DERIVATION AND PERSONNEL REQUIREMENTS

NETWORK DERIVATION

Methodology

In order to derive network requirements for an I/M program to be established on a statewide basis in Ohio, it is first necessary to make reasonable estimates as to the size of the vehicle population to be served by such a program, and the relative density of the vehicle population from county to county. Once these estimates have been made, it is possible to locate a network of inspection facilities across the state, taking into account various factors such as capacity and efficiency of these inspection facilities, accessibility and convenience to motorists, etc.

Vehicle Population Projections

Using detailed data provided by the Ohio Department of Highway Safety, Bureau of Motor Vehicles, and from the Ohio Environmental Protection Agency, it is possible to make estimates of the 1982 and 1987 inspectable vehicle populations. The 1982 and 1987 figures are of interest because the Clean Air Act Amendments of 1977 require full program implementation by 1982 and all network facilities will be designed to meet the demands of the 1987 vehicle population, thus ensuring that all facilities in the system will be able to operate for at least 5 years without additional investment in inspection capacity. Not all motor vehicles registered in Ohio will be subject to inspection; for various reasons, certain vehicle classes will be exempted. Among these are: those vehicles having a gross vehicle weight of greater than 8,500 lb, motorcycles, buses, vehicles greater than 12 years old, off-the-road vehicles, and certified research vehicles. Relating these exemptions to the "Detailed Statement of Motor Vehicle Registration and Revenue" issued annually by the Ohio Bureau of Motor Vehicles, results in the following assumptions:

1. All "passenger cars" will be subject to inspection.
2. All light duty trucks (LDT's) will be subject to inspection. According to the Bureau, LDT's make up 83.3 percent of the total reported as "trucks" on the detailed statement.
3. All "farm trucks" will be subject to inspection.

4. All other vehicle classes reported on the "Detailed Statement" ("Trailers", "House Vehicles", "Motorcycles", "Dealers", "Buses", "Church Busses", and "Publicly Owned Vehicles") will be exempt from inspection.

Based on these assumptions, the total statewide inspectable vehicle population for 1976 (the most recent available data) was 6,916,896 vehicles. This population may be projected forward to its 1982 and 1987 levels using several different approaches. Two such approaches are described in detail below.

First Projection Approach--

The first method of projection is quite simple; one starts with the 1976 inspectable vehicle population (as defined above) for each of the 88 counties in Ohio and increases them at a constant annual rate of 3 percent. This 3 percent growth rate very closely approximates the annual statewide growth in total vehicle registrations over the past 20 years; using this projection method results in a 1982 estimate of 8,259,000 inspectable vehicles and a 1987 estimate of 9,575,000 inspectable vehicles statewide.

Second Projection Approach--

The second projection approach also relies on relatively simple logic; in this approach, projected human population figures are multiplied by estimates as to the number of inspectable motor vehicles per capita to yield projections of the inspectable vehicle population. Human population projections for each county for 1982 and 1987 were obtained through linear interpolation of projection figures calculated by the Ohio Environmental Protection Agency in 1978. These figures, developed as part of the planning process mandated by Section 208 of the Clean Water Act, were generated by a cohort survival model. Input data for the model were developed from Ohio Department of Health Vital statistics for Ohio counties from 1970 to 1976, information from the Ohio Department of Economics and Community Development, and the U.S. Census Bureau. The model employed county-specific mortality, fertility, and immigration rates based on trends from 1960 to 1975. The ratio of inspectable vehicles per capita for 1982 and 1987 was developed for each county by dividing inspectable vehicles for 1975 obtained from the Bureau of Motor Vehicles "Detailed Statement" sheet, by the 1975 population figures which were used as the base year statistics for the OEPA projections, and projecting the result forward at a constant annual rate of 1-1/2 percent, a rate which closely approximates the ratio's annual growth from 1960 to 1975. Using this projection method results in a 1982 estimate of 7,829,000 inspectable vehicles and a 1987 estimate of 8,684,000 inspectable vehicles statewide.

Comparison of the Two Projection Methods--

Table 12 shows inspectable vehicle population estimates for 1982 and 1987 using both projection methods. For simplicity in tabulation, data have been aggregated by OEPA region; a map showing the boundaries of these regions and the counties contained in each is shown in Figure 7. With the few exceptions of counties experiencing extremely rapid growth, the first projection approach tends to result in higher estimates than the second approach. For this reason, the aggregate totals for each region are uniformly higher for the first approach than the second.

TABLE 12. INSPECTABLE VEHICLE POPULATION ESTIMATES FOR 1982 AND 1987 USING TWO PROJECTION APPROACHES

Approach	OEPA Region	1982	1987
First	Northwest	1,423,000	1,650,000
	Northeast	3,091,000	3,584,000
	Central	955,000	1,107,000
	Southeast	864,000	1,002,000
	Southwest	1,925,000	2,231,000
	Total	8,258,000	9,574,000
Second	Northwest	1,388,000	1,540,000
	Northeast	2,856,000	3,167,000
	Central	934,000	1,036,000
	Southeast	789,000	876,000
	Southwest	1,862,000	2,065,000
	Total	7,829,000	8,684,000

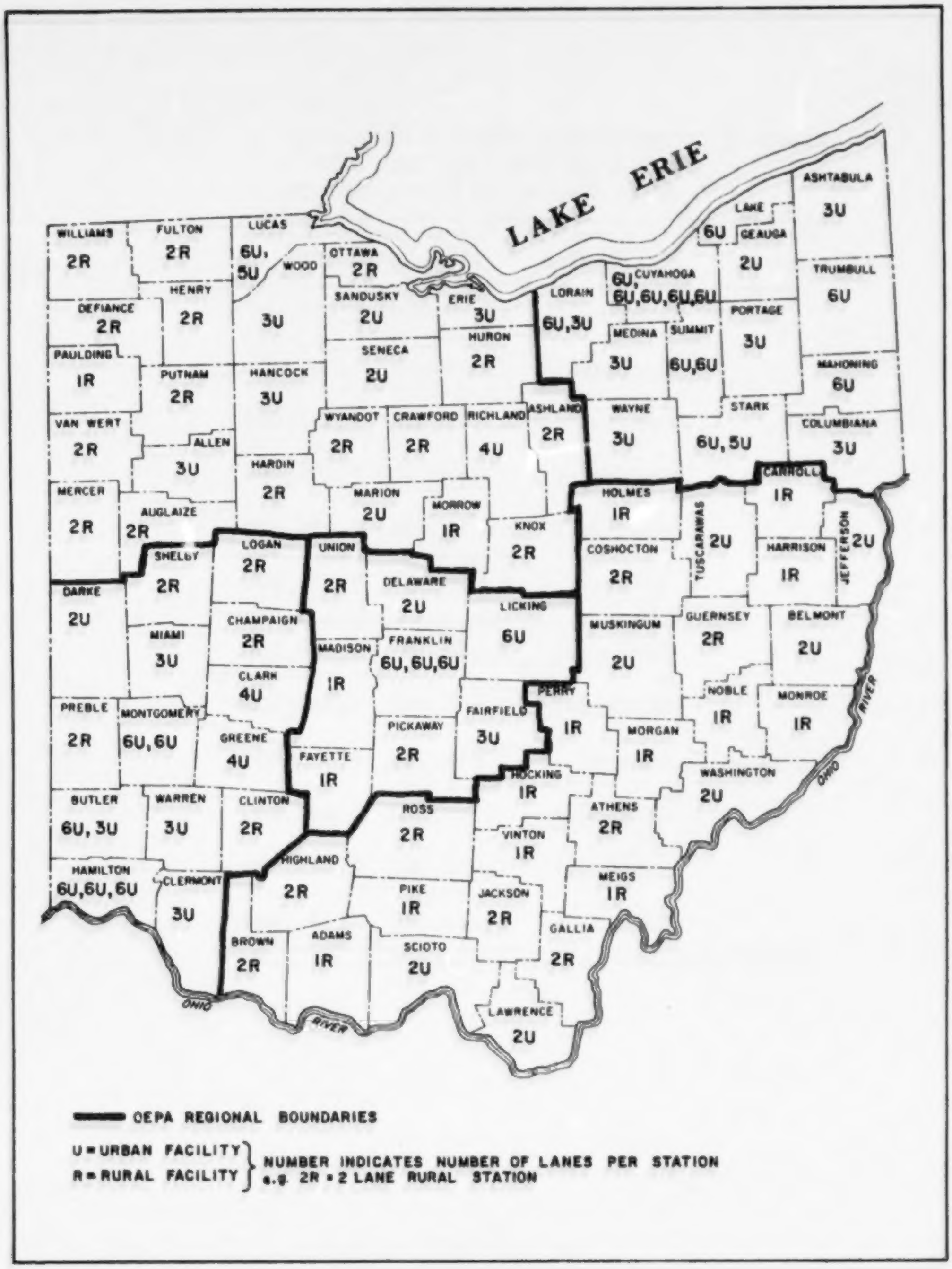
LAKE ERIE
WILLIAMS 2R
FULTON 2R
LUCAS 6U, 5U
WOOD 3U
OTTAWA 2R
SANDUSKY 2U
ERIE 3U
HURON 2R
LORAIN 6U,3U
CUYAHOGA 6U, 6U,6U,6U,6U
LAKE 6U
GEAUGA 2U
ASHTABULA 3U
TRUMBULL 6U
PORTAGE 3U
SUMMIT 6U,6U
MEDINA 3U
DEFIANCE 2R
HENRY 2R
PAULDING 1R
PUTNAM 2R
HANCOCK 3U
SENECA 2U
MAHONING 6U
VAN WERT 2R
ALLEN 3U
WYANDOT 2R
CRAWFORD 2R
RICHLAND 4U
ASHLAND 2R
WAYNE 3U
STARK 6U, 5U
COLUMBIANA 3U
MERCER 2R
AUGLAIZE 2R
HARDIN 2R
MARION 2U
MORROW 1R
KNOX 2R
HOLMES 1R
CARROLL 1R
TUSCARAWAS 2U
HARRISON 1R
JEFFERSON 2U
SHELBY 2R
LOGAN 2R
UNION 2R
DELAWARE 2U
LICKING 6U
COSHOCTON 2R
DARKE 2U
MIAMI 3U
CHAMPAIGN 2R
MADISON 1R
FRANKLIN 6U, 6U,6U
MUSKINGUM 2U
GUERNSEY 2R
BELMONT 2U
CLARK 4U
PREBLE 2R
MONTGOMERY 6U,6U
GREENE 4U
FAYETTE 1R
PICKAWAY 2R
FAIRFIELD 3U
PERRY 1R
MORGAN 1R
NOBLE 1R
MONROE 1R
WASHINGTON 2U
HOCKING 1R
ATHENS 2R
BUTLER 6U, 3U
WARREN 3U
CLINTON 2R
ROSS 2R
VINTON 1R
HAMILTON 6U,6U, 6U
CLERMONT 3U
HIGHLAND 2R
PIKE 1R
JACKSON 2R
MEIGS 1R
GALLIA 2R
BROWN 2R
ADAMS 1R
SCIOTO 2U
LAWRENCE 2U
OHIO RIVER
OHIO RIVER
OEPA REGIONAL BOUNDARIES
U = URBAN FACILITY
R = RURAL FACILITY
NUMBER INDICATES NUMBER OF LANES PER STATION
e.g. 2R = 2 LANE RURAL STATION

Figure 7. Station configurations, I/M network.

Advantages of the Second Projection Method--

The results obtained by the second projection method are clearly preferable to those obtained by the first for two reasons. First, while a constant annual growth rate of 3 percent maybe useful in making statewide vehicle population estimates, it may create problems when applied to county statistics. Particularly in those counties containing large cities, such as Cuyahoga and Summit, the annual growth rate has recently been much lower than 3 percent. Since these counties contain large concentrations of motor vehicles, applying a 3 percent growth rate would tend to greatly overestimate their 1982 and 1987 inspectable vehicle populations. Conversely, certain suburban counties, such as Delaware, Medina, Warren, and Wood, have recently experienced growth rates greater than 3 percent; applying the constant 3 percent growth rate in these counties would tend to underestimate their future vehicle populations. Also, the second projection method relies on much more sophisticated models of county growth which take into account a number of historical trends ignored by the first method. For these reasons, the results obtained from the second projeciton method will be used in the network derivation below.

Inspection Facilities

It can be seen from the table above, there is a considerable variation in the number of inspectable vehicles projected for 1982 and 1987 from region to region. In highly urbanized regions, such as Northeast Ohio, the concentration of inspectable vehicles per county is very high; as a result, the vehicle inspection system for these areas has been designed to operate on a high-volume basis. Every available means of reducing the throughput, or the length of time required to complete the inspection process of one vehicle, has been incorporated into these facilities. They will use highly automated emissions analysis equipment and 3-stop "assembly line" approach to maximize inspection efficiency. A typical inspection lane in urban areas should be able to process a new vehicle every two minutes when operating at normal efficiency. By making several additional assumptions, it is possible to relate this 2-minute throughput into an annual total figure of vehicles processed per inspection lane. These assumptions are as follows:

1. Inspection facilities will be open 40 hours per week, 52 weeks per year.

2. On average, a typical inspection lane will operate at 67 percent of its peak efficiency. This assumption is made to account for the fact that motorists arrive at the facility randomly, and there are quite likely to be times when the inspection equipment is underutilized.

Based on these assumptions, the annual capacity of an urban inspection lane is:

$$\frac{60\text{ min/hr}}{2\text{ min/inspection}}\ (40\text{ hr/wk})(52\text{ wk/yr})(0.67)$$

$$= 41{,}808\text{ inspections/yr.}$$

In rural regions, such as Southeast Ohio, the concentration of inspectable vehicles per county is significantly lower than in the urbanized regions. As a result, the vehicle inspection system for these rural regions has been designed to operate somewhat differently than the urban system described.

In certain rural counties, the inspectable vehicle population is so small that construction of even one of the above inspection lanes would not be warranted; as a result, rural inspection facilities will be smaller, require fewer employees, and incorporate longer throughput times than the urban facilities. Emissions analysis equipment will still be completely automated so as to reduce human error and facilitate record keeping. The rural inspection lanes, however, will incorporate only two vehicle stops. A typical rural inspection lane operating at normal efficiency should be able to process a new vehicle every three minutes. Using the same assumptions regarding efficiency and working hours as above, the annual capacity of a rural inspection lane is:

$$\frac{60 \text{ min/hr}}{3 \text{ min/inspection}} (40 \text{ hr/wk})(52 \text{ wk/yr})(0.67)$$

$$= 27{,}872 \text{ inspections/yr.}$$

Once the annual capacities of urban and rural inspection lanes have been derived, it is possible to allocate lanes to each county based on the estimated number of inspectable vehicles in 1987. In making these allocations, the following assumptions have been used:

1. Due to the fact that inspection cut points will be set such that 20 percent of those vehicles inspected will fail and require reinspection, the total number of inspections performed in 1987 will be 1.2 times the figures reported previously in Table 4.1. Table 4.2 shows the number of inspections required in each of the 88 counties in 1987, using the second projection method.

2. In urban counties, due to the problems associated with locating suitable large parcels, and their high cost, maximum facility size was limited to six lanes. Conversely, due to diseconomies of scale associated with one-lane urban facilities, minimum urban facility size was set at two lanes.

3. In rural counties, which for the purposes of this analysis were defined as those counties containing fewer than 83,600 vehicles (the capacity of a 2-lane urban facility), facilities of one or two lanes will be constructed, depending on whether or not annual 1978 inspection demand is less or greater than 27,900 vehicles, the annual capacity of a rural inspection lane.

4. To maximize public convenience, at least one facility was allocated to each county. In the very rural counties of the Southeast region, particularly Morgan, Monroe, Vinton, and Noble, construction of a one-lane rural facility would not be warranted solely on economic considerations. However, to reduce travel time

to and from inspection facilities for residents of these counties, one-lane rural facilities were allocated to them.

5. Facilities were located so as to be as near as possible to concentrations of population (and, therefore, motor vehicles). In urban counties they are located in the large cities; in rural areas, they are generally located in the county seat or the geographic center of the county in order to minimize travel distances and maximize public convenience.

Tables 14 through 18 reports the number of inspections required in 1987 the projected inspection facility configurations, and the general location of each facility in the 5 OEPA regions.

For purposes of cost analysis, it is useful to determine the average number of inspections performed each year during the 1982 through 1987 period. Since the inspectable vehicle population is growing, the revenues collected from inspection fees will be greater in 1987 than 1982. Dividing total system costs by this average number of inspections gives a more accurate approximation of what the inspection fee will be during the 5 year period. Table 13 shows the number of inspections performed each year and the 5 year average.

TABLE 13. INSPECTIONS PERFORMED ANNUALLY, 1982 THROUGH 1987

Year	Inspection Performed
1982	9,396,000
1983	9,593,000
1984	9,793,000
1985	9,998,000
1986	10,207,000
1987	10,420,000
Average	9,901,000

TABLE 14. INSPECTION NETWORK, NORTHWEST REGION

County	Inspections Required, 1987	Facility	Location
Allen	134,000	3-lane urban	Lima
Ashland	54,000	2-lane rural	Ashland
Auglaize	51,000	2-lane rural	Wapakoneta
Crawford	65,000	2-lane rural	Bucyrus
Defiance	52,000	2-lane rural	Defiance
Erie	104,000	3-lane urban	Sandusky
Fulton	51,000	2-lane rural	Wauseon
Hancock	107,000	3-lane urban	Findlay
Hardin	37,000	2-lane rural	Kenton
Henry	42,000	2-lane rural	Napoleon
Huron	66,000	2-lane rural	Norwalk
Knox	56,000	2-lane rural	Mt. Vernon
Lucas	532,000	6-lane urban	Toledo
		5-lane urban	Maumee
Marion	82,000	2-lane urban	Marion
Mercer	49,000	2-lane rural	Celina
Morrow	34,000	1-lane rural	Mt. Gilead
Ottawa	49,000	2-lane rural	Port Clinton
Paulding	28,000	1-lane rural	Paulding
Putnam	42,000	2-lane rural	Ottawa
Richland	166,000	4-lane urban	Mansfield
Sandusky	80,000	2-lane urban	Fremont
Seneca	74,000	2-lane urban	Tiffin
Van Wert	39,000	2-lane rural	Van Wert
Williams	48,000	2-lane rural	Bryan
Wood	145,000	3-lane urban	Bowling Green
Wyandot	29,000	2-lane rural	Upper Sandusky
Totals	2,216,000	33 urban lanes; 32 rural lanes;	10 urban stations 17 rural stations

TABLE 15. INSPECTION NETWORK, NORTHEAST REGION

County	Inspections Required, 1987	Facility	Location
Ashtabula	122,000	3-lane urban	Ashtabula
Columbiana	131,000	3-lane urban	Lisbon
Cuyahoga	1,558,000	6-lane urban	Cleveland
		6-lane urban	Euclid
		6-lane urban	Lakewood
		6-lane urban	Parma
		6-lane urban	Garfield Heights
Geauga	86,000	2-lane urban	Chardon
Lake	267,000	6-lane urban	Painesville
Lorain	362,000	6-lane urban	Elyria
		3-lane urban	Lorain
Mahoning	327,000	6-lane urban	Youngstown
Medina	150,000	3-lane urban	Medina
Portage	138,000	3-lane urban	Kent
Stark	440,000	6-lane urban	Canton
		5-lane urban	Alliance
Summit	558,000	6-lane urban	Akron
		6-lane urban	Cuyahoga Falls
Trumbull	306,000	6-lane urban	Warren
Wayne	116,000	3-lane urban	Wooster
Totals	4,561,000	97 urban lanes,	20 facilities

TABLE 16. INSPECTION NETWORK, CENTRAL REGION

County	Inspection Required, 1987	Facility	Location
Delaware	79,000	2-lane urban	Delaware
Fairfield	119,000	3-lane urban	Lancaster
Fayette	33,000	1-lane rural	Washington Court House
Franklin	983,000	6-lane urban	Columbus
		6-lane urban	Upper Arlington
		6-lane urban	Whitehall
Licking	160,000	6-lane urban	Newark
Madison	27,000	1-lane rural	London
Pickaway	54,000	2-lane rural	Circleville
Union	37,000	2-lane rural	Marysville
Totals	1,492,000	29 urban lanes; 6 rural lanes;	6 urban stations 4 rural stations

TABLE 17. INSPECTION NETWORK, SOUTHEAST REGION

County	Inspections Required, 1987	Facility	Location
Adams	28,000	1-lane rural	West Union
Athens	48,000	2-lane rural	Athens
Belmont	90,000	2-lane urban	St. Clairsville
Brown	37,000	2-lane rural	Georgetown
Carroll	32,000	1-lane rural	Carrollton
Coshocton	43,000	2-lane rural	Coshocton
Gallia	37,000	2-lane rural	Gallipolis
Guernsey	49,000	2-lane rural	Cambridge
Harrison	22,000	1-lane rural	Cadiz
Highland	41,000	2-lane rural	Hillsboro
Hocking	26,000	1-lane rural	Logan
Holmes	24,000	1-lane rural	Millersburg
Jackson	36,000	2-lane rural	Jackson
Jefferson	96,000	2-lane urban	Steubenville
Lawrence	68,000	2-lane urban	Ironton
Meigs	29,000	1-lane rural	Pomeroy
Monroe	18,000	1-lane rural	Woodsfield
Morgan	16,000	1-lane rural	McConnellsville
Muskingum	93,000	2-lane urban	Zanesville
Noble	17,000	1-lane rural	Caldwell
Perry	35,000	1-lane rural	New Lexington
Pike	29,000	1-lane rural	Waverly
Ross	69,000	2-lane urban	Chillicothe
Scioto	92,000	2-lane urban	Portsmouth
Tuscarawas	95,000	2-lane urban	New Philadelphia
Vinton	15,000	1-lane rural	McArthur
Washington	77,000	2-lane urban	Marietta
Totals	1,262,000	16 urban lanes; 26 rural lanes;	8 urban stations 19 rural stations

TABLE 18. INSPECTION NETWORK, SOUTHWEST REGION

County	Inspections Required, 1987	Facility	Location
Butler	292,000	6-lane urban	Hamilton
		3-lane urban	Middletown
Champaign	39,000	2-lane rural	Urbana
Clark	174,000	4-lane urban	Springfield
Clermont	153,000	3-lane urban	Batavia
Clinton	41,000	2-lane rural	Wilmington
Darke	72,000	2-lane urban	Greenville
Greene	162,000	4-lane urban	Xenia
Hamilton	939,000	6-lane urban	Cincinnati
		6-lane urban	Norwood
		6-lane urban	Reading
Logan	48,000	2-lane rural	Bellefontaine
Miami	130,000	3-lane urban	Troy
Montgomery	697,000	6-lane urban	Dayton
		6-lane urban	Kettering
Preble	39,000	2-lane rural	Eaton
Shelby	54,000	2-lane rural	Sidney
Warren	133,000	3-lane urban	Lebanon
Totals	2,973,000	58 urban lanes; 10 rural lanes;	13 urban stations 5 rural stations

PERSONNEL REQUIREMENTS

Personnel requirements for a contractor-operated statewide I/M program in Ohio can be described in terms of five separate categories, depending on employer and scope of responsibility. The 5 categories are as follows (see Figures 8 and 9):

1. State of Ohio - Statewide responsibility. Under this category are those employees of the State of Ohio who exercise statewide control over various aspects of the program. They include:

    A. Administrator - The Administrator, an OEPA employee, would be responsible for overall day-to-day management of the program, as well as for planning of future program operations. All policy decisions would originate from the Administrator's office. Under the Administrator would be two Assistant Administrators.

    B. Assistant Administrator for Supporting Services - This OEPA employee would be responsible for direction of all supporting services including planning and budget preparation, required by the I/M program, not including actual inspections or other functions performed by contractors.

    C. Assistant Administrator for Field Operations - This OEPA employee would be responsible for management of all operations dealing with inspections, reinspections, or waiver issuance by the contractor. He would direct all contractor activities with input from the supporting services officers.

    D. Legal Counsel - This OEPA employees, serving under the Assistant Administrator for Supporting Services, would handle all legal matters arising from the Administration of the I/M program.

    E. Purchasing Officer - This OEPA employee would be responsible for all equipment acquisitions relative to program operations that were not provided by the contractor.

    F. Accountant - This OEPA employee would be responsible for keeping accurate records of collection and disbursement of program funds, including inspection fees.

    G. Contracts Officer - This OEPA employee would be responsible for negotiation with and acquisition of goods and services from all sources not directly supplying the contractor.

H. Engineer - This OEPA employee would be responsible for overview of all data acquisition and handling and record keeping, and would report regularly to the Assistant Administrator for Supporting Services on any program developments that might need attention by program policymakers.

I. Statistician/Programmer - This OEPA employee would develop methods for tabulation, analysis, and review of program data collected on the contractor's computer system. Results of these analyses would be made available to the Quality Assurance and Consumer Protection functions.

J. Systems Analyst/Programmer - This OEPA employee would conduct studies of contractor operations to determine their overall efficiency and cost effectiveness.

K. Public Relations Coordinator - This OEPA official, with direction from the Administrator would be responsible for development of a statewide public information program designed to inform the general public and elicit support for the program.

L. Calibration Overseer - This OEPA employee would be responsible for direction of all quality assurance/calibration activities not carried out by the contractor.

M. Three Hotline Operators - These OEPA personnel would receive consumer complaints regarding program operation and refer them to the proper authority for resolution.

2. State of Ohio - Regional Responsibility. Under this category are those employees of the State of Ohio who exercise control over a single OEPA region in which they are stationed. They include:

A. Five Regional Calibration Investigators (one per region) - These OEPA employees will be responsible for conducting regular calibration tests on contract-operated emissions analyzers, as well as unannounced spot checks.

B. Ten Regional Complaints Investigators (two per region) - These OEPA personnel are responsible for following up on complaints referred to them by the OEPA toll-free complaints Hotline operators.

C. Five Fleet Calibration Coordinators (one per region) - These OEPA personnel are responsible for performing regular calibration tests on analyzers operated by fleet owners in lieu of having the contractor perform emissions test on their vehicles. (In Ohio, a "fleet" is defined as a group of 25 or more vehicles.)

3. Contractor - Statewide Responsibility. Under this category are those employees of the contractor who exercise statewide control over various aspects of the program with the guidance and direction of the OEPA. On the state level, the contractor would employ a number of personnel having functions similar to, and coordinating their activities very closely with, the state employees already described. These contractor personnel include:

   A. Administrator for Station Operations

   B. Legal Counsel

   C. Purchasing Officer

   D. Accountant

   E. Contracts Officer

   F. Engineer

   G. Systems Analyst

   In addition the contractor would also employ on the state level:

   H. Inspector Training Coordinator - This contractor employee will develop and establish programs for the training of all inspection station personnel employed by the contractor.

4. Contractor - Regional Responsibility. Under this category are those contractor employees who exercise responsibility over a program function within a single OEPA region. These would include:

   A. Five Regional Managers (one per region) - These contractor employees would be directly responsible for performance of all contractor functions within a given OEPA region. They would report to and receive guidance from, both state and contractor management.

   B. Five Labor Relations Officials (one per region) - These contractor employees would serve as liaison between station personnel and contractor management personnel. They would represent station personnel in any labor disputes which might arise.

   C. Five Instrument Repair Technicians (one per region) - These contractor employees would repair and restore serviceability of any equipment which breaks down.

    D. Five Public Relations Officials (one per region) - These contractor employees would work very closely with the statewide Public Relations Coordinator to develop a high-quality public information program which reinforces public confidence in contractor activities.

    E. Five Calibration and Maintenance Coordinators (one per region) - These contractor employees will be responsible for overall management of the contractor quality assurance program, which includes regular calibration and maintenance of all contractor analyzer equipment.

    F. Thirty-one Mobile Calibration and Maintenance Officials (one for every 10 contractor inspection lanes) - These contractor employees would travel from station to station, conducting calibration tests on contractor analyzer equipment. They would receive guidance from and report regularly to the Regional Calibration/Maintenance Corrdinators.

5. Contractor - Local Responsibility. Under this category would be all contractor employees at the inspection station level. These would include:

    A. Fifty-seven Urban Station Managers - These contractor personnel would be responsible for the day-to-day operation of a single rural inspection facility.

    B. Forty-five Rural Station Managers - These contractor personnel would be responsible for the day-to-day operation of a single rural inspection facility.

    C. Fifty-seven Urban Station Assistant Managers - These contractor personnel would assist the urban station managers in the performance of all duties required by the contractor and the state.

    D. Eight Hundred and Forty-seven Station Inspectors - These contractor personnel will be responsible for performance of actual inspection functions, explanation of the test to consumers, and counseling to those motorists whose vehicles fail inspection. There will be 3 Inspectors per urban inspection lane and 2 Inspectors per rural inspection lane.

In addition to the contractor who provides all inspection services, a separate contractor would be employed by the State to develop and establish mechanic's training programs for private garage mechanics and other personnel who would be in charge of performing maintenance of failed vehicles. At this point, the details of this separate contractor program are rather uncertain; see Section 6 which discusses Mechanic Training Program Alternatives in more detail.

Table 19 shows a breakdown of all program employees into the five categories described above.

TABLE 19. PROGRAM EMPLOYEES

Personnel Category	Number of Employees
State - Statewide	12
State - Regional	25
State - Total	37
Contractor - Statewide	8
Contractor - Regional	51
Contractor - Local	996
Contractor - Total	1055

Figures 8 and 9 show in chart form the various divisions and directions of responsibility within the state and the contractor management systems.

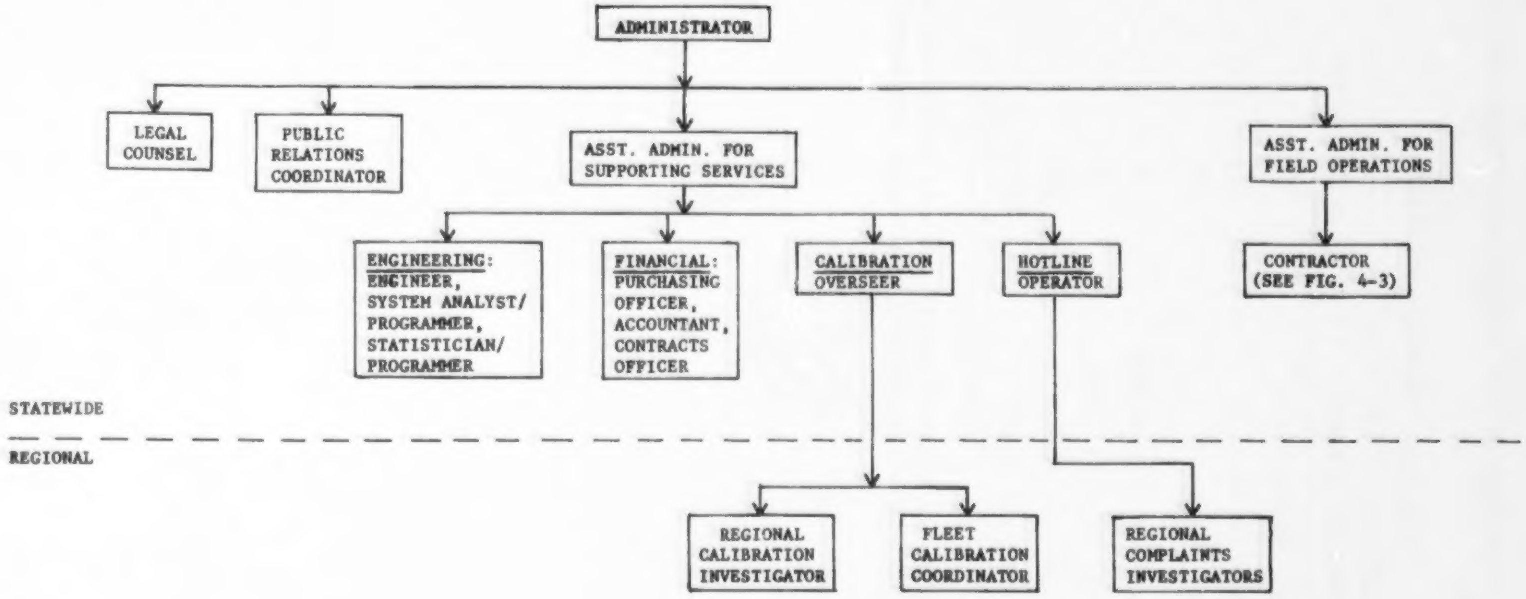
ADMINISTRATOR
LEGAL COUNSEL
PUBLIC RELATIONS COORDINATOR
ASST. ADMIN. FOR SUPPORTING SERVICES
ASST. ADMIN. FOR FIELD OPERATIONS
ENGINEERING: ENGINEER, SYSTEM ANALYST/ PROGRAMMER, STATISTICIAN/ PROGRAMMER
FINANCIAL: PURCHASING OFFICER, ACCOUNTANT, CONTRACTS OFFICER
CALIBRATION OVERSEER
HOTLINE OPERATOR
CONTRACTOR (SEE FIG. 4-3)
STATEWIDE
REGIONAL
REGIONAL CALIBRATION INVESTIGATOR
FLEET CALIBRATION COORDINATOR
REGIONAL COMPLAINTS INVESTIGATORS

Figure 8. State Administrative Network.

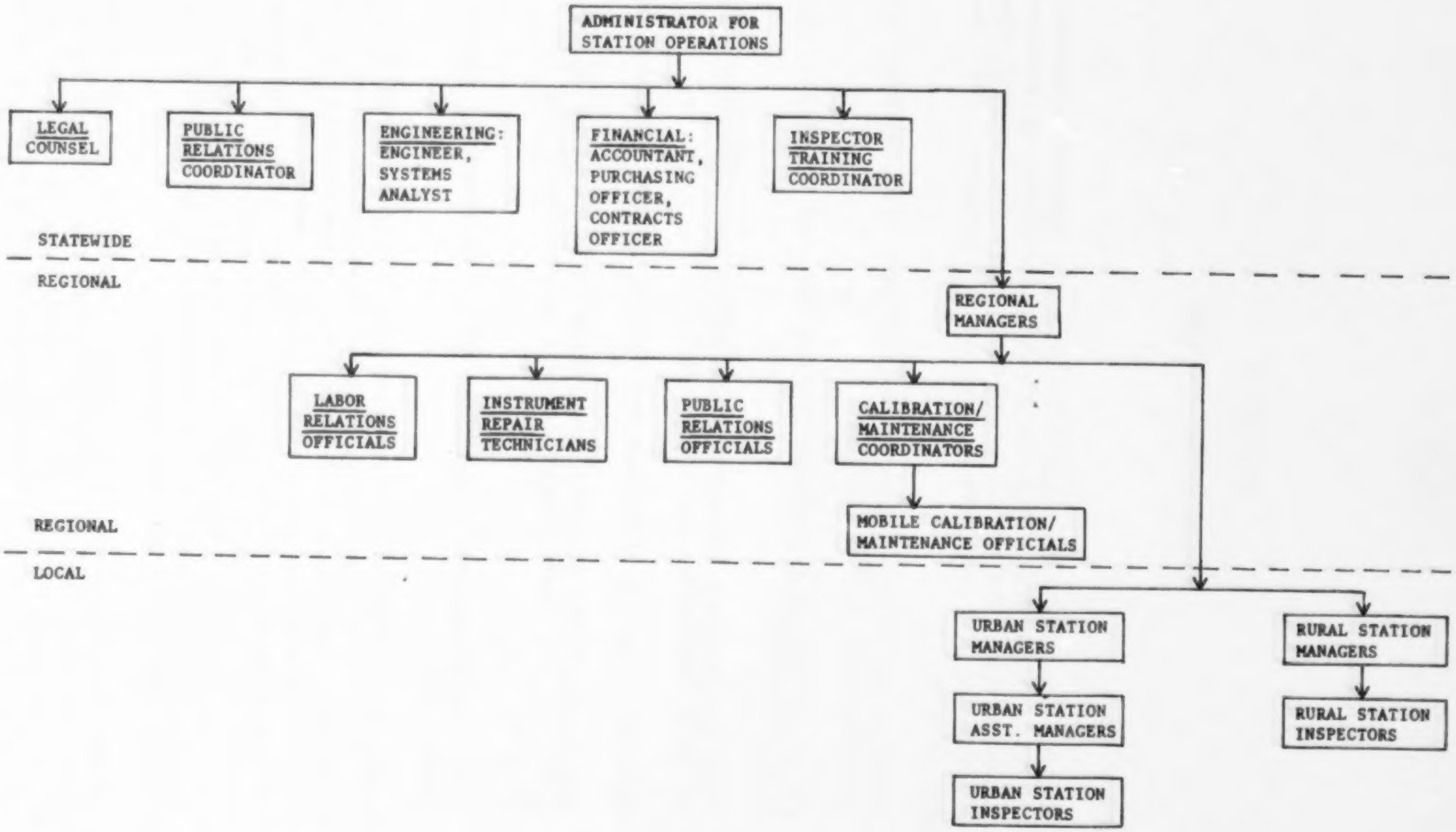
ADMINISTRATOR FOR STATION OPERATIONS
LEGAL COUNSEL
PUBLIC RELATIONS COORDINATOR
ENGINEERING: ENGINEER, SYSTEMS ANALYST
FINANCIAL: ACCOUNTANT, PURCHASING OFFICER, CONTRACTS OFFICER
INSPECTOR TRAINING COORDINATOR
STATEWIDE
REGIONAL
REGIONAL MANAGERS
LABOR RELATIONS OFFICIALS
INSTRUMENT REPAIR TECHNICIANS
PUBLIC RELATIONS OFFICIALS
CALIBRATION/ MAINTENANCE COORDINATORS
MOBILE CALIBRATION/ MAINTENANCE OFFICIALS
REGIONAL
LOCAL
URBAN STATION MANAGERS
URBAN STATION ASST. MANAGERS
URBAN STATION INSPECTORS
RURAL STATION MANAGERS
RURAL STATION INSPECTORS

Figure 9. Contractor network.

SECTION 6

ADJUNCTIVE PROGRAMS

INTRODUCTION

This section describes the adjunctive or basic support program elements. It includes quality assurance, mechanic training, consumer protection, public convenience, enforcement and public relations. What they have in common is that they all enhance the effectiveness of the I/M program. This includes the following functions:

- consumer protection protects the consumer from unneeded repairs or inequities in the testing
- public convenience minimizes travel time and waiting at the inspection lanes
- quality assurance increases the quality and uniformity of the emission inspection and repair process
- mechanic training increases the quality of the emission repairs
- public relations provides comprehensive information to the public on the needs, benefits, and procedures of the I/M program
- enforcement ensures a maximally effective system to ensure compliance

It is important that these adjunctive programs interrelate and overlap to a high degree. Some of the adjunctive program elements may serve multiple purposes. For example, mechanics training serves to increase the quality control of the repair or maintenance phase of the program, serves as an important consumer protection element by encouraging more uniform, less expensive emission tuneups and also may serve as a public relations mechanism by orienting the mechanics to the purpose and benefits of the overall I/M program. Given the multiple purpose nature of many of the adjunctive programs then, there is necessarily some overlap in the discussions.

The methodology consisted of two basic elements. The first element was an analysis of the overall inspection and maintenance process in reference to each adjunctive program element. The second part was extensive research into all published sources of information on the program being investigated.

This also included contacts and visits to various I/M programs around the country, calls to various governmental agencies, especially the U.S. Environmental Protection Agency which has conducted or sponsored much of the research and set the basic policy for I/M programs, and finally contacts with companies currently running I/M programs such as Hamilton Test Systems in Arizona as well as emission inspection equipment manufacturers.

CONSUMER PROTECTION

An effective consumer protection program is highly important for a successful I/M program. It is important from the point of view of protecting the public from unnecessary costs and inconveniences and equally important in securing general public acceptance and avoiding a significant buildup of adverse publicity. Among such consumer protection and convenience measures are public relations elements, although the primary aim of these elements is ensuring protection from inequities in either the inspection or the maintenance phase of the program. In this discussion, consumer protection will be dealt with first and then, consumer convenience.

Consumer protection mechanisms are generally of two types. First, there are specific active procedures set up to deal with consumer complaints as they occur. These are consumer hotlines and complaints investigators. Second, there are features built into the system that directly or indirectly protect consumers from potential inequities or abuses. These include state motor vehicle repair regulations, repair cost ceilings, waivers or exemptions, repair facility or mechanic licensing or approval, and warranty regulations (both federal and state).

Existing Consumer Protection Mechanisms

Before discussing the consumer protection mechanisms to be added for the I/M program, the various regulations and mechanisms that already exist in Ohio must be understood.

The Consumer Protection Division of the Ohio Attorney General's Office deals with consumer complaints. The Ohio Consumer Sales Practice Act gives the Attorney General the basic authority to establish regulations that concern the repair industry. According to these regulations, disclosure requirements establish that a repair shop must provide the customer with an estimate prior to performing repairs. The repair facility must submit a form to the customer that indicates whether he wants a written estimate, an oral estimate or if he elects to waive the requirement. If a written or oral estimate is requested then, prior authorization must be obtained if the repairs will exceed the estimate by 10 percent or more. In terms of new car sales, regulations exist that establish limitations on advertising. These regulations stipulate that any representations made either verbally or otherwise must be written into the contract in order to be valid and binding.

The Ohio EPA currently operates a consumer hotline in the Division of Environmental Information within the Public Interest Center. Calls are received concerning various consumer complaints or requests having to do with environmental problems. The calls are referred to the Public Information Center if they only require information or to the other departments of the OEPA if they require other actions.

The existing consumer complaints mechanism consists of consumer hotlines and investigators both of which are also operated through the Consumer Protection Division of the Attorney General's Office. When a consumer calls the hotline, which is a statewide toll-free "800" number, he is sent a complaint form to fill out and return. A staff member (complaint handler) then contacts the repair facility or automobile dealer and tries to work out the problem. If the problem cannot be resolved to the satisfaction of both parties, a member of the Division's Investigative Staff is called in. He will then visit the facility to attempt to resolve the grievance. If a violation of law is discovered the case is turned over to a staff lawyer. Action for restitution or damages may then be initiated. There are 4,000 to 5,000 calls a year dealing with complaints about automobile dealers or repair shops. Most of these cases are taken care of without resort to litigation or court proceedings.

Consumer Hotlines and Complaints Investigation

Consumer hotlines serve two important functions in the I/M program. First, they provide valuable information to the public regarding basic operating times and locations of the inspection lanes, procedures, consumer rights and obligations, and other related information. Second, and equally important, the hotlines are centralized referral points to guide the consumer after an evaluation of his problem to the correct department. In many cases, all that is needed is correct information, but when a significant problem requires the attention of a particular department the consumer can then be routed to the right office. Also, hotline personnel are trained in dealing with the public and thus can make a significant contribution to the overall public relations effort of the overall I/M program. It is very important that all contacts between the public and I/M personnel be smooth and harmonious, especially given the somewhat controversial nature of the program.

The I/M program hotlines should be established in the Ohio Environmental Protection Agency. Informational calls could be processed through the existing hotlines in the Division of Environmental Information in the Public Interest Center. Other calls about the I/M program operation would be routed to the Department or Division running the I/M program in Ohio EPA. These hotlines would serve the above-named functions by providing information and referral to appropriate agencies. When complaints concern the inspection test process at contractor inspection lanes, mobile complaints investigators would be assigned to cases that required followup and actual visits to the inspection stations. Also, records should be kept on any stations causing a significantly large number of complaints. Complaints regarding repair facilities can be referred to hotlines currently run by the Consumer Protection Division of the Attorney General's Office. This procedure is described above in the existing consumer protection discussion.

Repair Costs Limits

The repair cost limit is a maximum cost that a motorist is obligated to spend on repairs for his motor vehicle in order to meet the emission standards. This cost ceiling helps prevent the program from becoming an excessive burden on vehicle owners, especially those in lower income brackets. Also, on certain vehicles the cost of complying may be so great as to make operation prohibitively expensive. However, it should be clearly stated that the vehicle owner is in no way compelled to keep the repairs below the specified limit. For those who can easily afford the extra costs or who desire to achieve full compliance, there should be strong encouragement to do so.

Repair costs may be cumulative. In some cases a motorist may fail the retest and return to the repair shop again for repairs. The repair cost limit applies to the cumulative emission repairs for the entire sequence within a specified time limit after failing the emission test.

Repair cost limits are generally of two types. First, an absolute dollar limit and second, a sliding scale related to the value of the vehicle. In the first approach a fixed upper limit generally from $50 to $100 is set which applies to all vehicles regardless of their age, conditions, or resale value. In the second approach, which in theory is more equitable, the price ceiling relates to the vehicle value as determined by an accepted reference of average retail prices. The Minnesota I/M revised statute, Section 5, reads as follows:

> "Maximum Repair Cost. 1(a) The maximum repair cost for meeting emission standards, not covered by any warranty, shall be as follows: a motor vehicle having a value of $2,000 or less, $50, for each full $500 of vehicle value over $2,000, an additional $10. Motor vehicle values shall be determined as provided in Minnesota Statutes, Section 168-013."

The data presented in Table 19a give an indication of the average repair costs experiences in various I/M programs around the country.

Waivers and Exemptions

Granting of exemptions for specific vehicle types, in addition to vehicles exceeding the repair cost ceiling, is another consumer protection mechanism. The reasons for these exemptions are discussed in Section 3, Option Definition. Ohio has chosen to exempt the following categories of motor vehicles:

- buses and trucks greater than 8,500 lb GVW
- motorcycles and motorized bicycles
- off-the-road vehicles (ORV's) not used in public highways
- racing cars used solely for exhibition purposes and not in public highways

TABLE 19a. I/M REPAIR COSTS

New Jersey

Less than $10	29.7%
$10 - $25	26.4%
$25 - $50	22.1%
$50 - $100	16.1%
Over - $100	5.6%

N = 16,000
Average repair costs = $32.40
Median - 50% of repairs cost less than $20
65% of repairs cost less than the average

Oregon

No cost	27%
$0 - $10	37%
$10 - $30	18%
$30 - $50	8%
$50 - $75	5%
Over $100	2%

N = 1400 (primarily newer cars)
Average repair costs = $16.00
Median - 50% of repairs cost less than $8
71% of repairs cost less than the average

Arizona

Less than $5	27%
$5 - $10	17%
$10 - $25	24%
$25 - $50	20%
$50 - $100	10%
Over $100	2%

N = 2000
Average repair cost = $23.40
Median - 50% of repairs cost less than $15
64% of repairs cost less than average

Failure rates - New Jersey - 12% (annual)
Arizona - 16% (annual)
Oregon - 36% (biannual)

- certified research vehicles
- permanent four-wheel drive vehicles
- certified historic (antique) vehicles

The following categories will not be exempt:

- farm trucks
- diesel cars and trucks under 8,500 lb GVW

Light-duty diesel vehicles (cars) and light-duty diesel trucks are being included in the I/M program because it is estimated that to meet the increasingly tough emission and gas mileage standards manufacturers fleets will include from 25 to 35 percent diesels by 1987.

Licensing, Certification, or Approval of Repair Facilities and Mechanics

Licensing or certification of repair shops and mechanics are mechanisms for ensuring that repairs are done adequately and at a reasonable cost to the consumer. As such, they are important as consumer protection elements. The type and degree of regulation of private industries such as repair shops by state government is a sensitive issue but given the need to ensure protection of the consumer and the adequacy of repair, some type of influence on repair industry practices is crucial. An active mechanic training program in emission-related tuneup and emission repairs has been shown to have a very beneficial impact on upgrading mechanic skills and fostering a positive attitude toward emission control. Mechanic training will be discussed later in this section.

Most states and repair industry groups do not look favorably at formal licensing of repair shops and mechanics; rather, they view it as interference in private industry. Of course, when the repair facilities are designated as official inspection stations then some sort of official licensing and close supervision is very important for both consumer protection and quality assurance considerations. However, in the contractor approach being considered in Ohio, the same degree of state supervision is less critical. Generally there are two reasons for needing some supervision or influence on the private repair facilities: emission analyzer calibration and accuracy and control of unauthorized repair practices. Rather than formal licensing of repair facilities, which allow only licensed facilities to perform emission repairs, a lesser degree of control in the form of certification or approval would be recommended. Given the need for using reasonably accurate and reliable analyzers, many states publish lists of approved emission analyzers. New Jersey has one such list. A repair facility may become approved or certified if it utilized an approved analyzer. In addition, the state may require that the facility employ emission tuneup mechanics who have taken approved mechanic training courses. Furthermore, the state could have each approved analyzer calibrated at regular intervals.

The approach recommended for Ohio is certification of repair facilities that would require having approved emission analyzers. An important aspect of the program is the need to build in sufficient incentives to motivate as many of the repair facilities as possible to become certified. By allowing the certified stations to display the certification and to publicize certified stations, tends to increase repair business. Other competing stations would become aware of the advantages of certifications for increasing their business and would tend to seek certification. Consequently, the basic incentives towards better quality repairs and consumer protection would be inherent in the certification requirements. After the program has been in operation for a period of time, the need to have closer state surveillance of the private repair facilities, especially in terms of analyzer calibration should be evaluated by the state. If most vehicles pass the retest after the appropriate repairs are made and other indications such as consumer complaints are minimal, then there would seem to be little justification for increased state supervision. Presumably, it is most desirable from an economic and political prespective to minimize unnecessary state involvement or regulation of private repair industry.

Warranty Protection

Motor vehicles are generally covered by warranty provisions. These provisions vary considerably from one manufacturer to another by the length (time and mileage) of coverage as well as in terms of what parts or systems of the motor vehicle to which the warranty applies. Some states have consumer protection regulations that require new and used car dealers to provide to the buyer at the time of sale the exact conditions of the warranty. Even without explicit provisions on warranties, however, the consumer may have recourse to the Ohio Attorney General's Office if the car dealer refuses to comply with the warranty conditions because it is essentially a legal contract enforceable by law. Of greatest significance to the I/M programs, however, is the specific warranty provisions regarding emission control equipment and systems. These systems have not been covered by manufacturers warranties that generally only apply to the engine and drive train and extend for 24,000 miles. In view of the possible failure of emission control devices over time on in-use vehicles and due to the importance of their integrity to ensure continued emission reduction, the federal government has established warranty regulations. These are promulgated in Section 207(b) of the Clean Air Act Amendments of 1977.

The intent of these warranty provisions was to ensure that the basic emission control equipment be manufactured such that it would last up to 50,000 miles or 5 years, whichever came first. As such 207(b) may be seen as an incentive for manufacturers to design the basic emission control equipment to last at least up to the end of the warranty period. There is still much debate about what should be the best warranty period and suggestions have been made to have the warranty extended to the entire useful life of the vehicle or 100,000 miles. The actual wording of section 207(b) is as follows:

> "(b) If the Administrator determines that (i) there are available testing methods and procedures to ascertain whether, when in actual use throughout its useful life (as determined under section 202(d)), each vehicle and engine to which regulations under section 202 apply complies with the emission standards of such regulations, (ii) such methods and procedures are in accordance with good engineering practices, and (iii) such methods and procedures are

> reasonably capable of being correlated with tests conducted under section 206(a)(1), then-
>
> (1) he shall establish such methods and procedures by regulation, and
>
> (2) at such time as he determines that inspection facilities or equipment are available for purposes of carrying out testing methods and procedures established under paragraph (1), he shall prescribe regulations which shall require manufacturers to warrant the emission control device or system of each new motor vehicle or new motor vehicle engine to which a regulation under section 202 applies and which is manufactured in a model year beginning after the Administrator first prescribes warranty regulations under this paragraph. The warranty under such regulations shall run to the ultimate purchaser and each subsequent purchaser and shall provide that if—
>
> (A) the vehicle or engine is maintained and operated in accordance with instructions under subsection (c)(3),
>
> (B) it fails to conform at any time during its useful life (as determined under section 202(d)) to the regulations prescribed under section 202, and
>
> (C) such nonconformity results in the ultimate purchaser (or any subsequent purchaser) of such vehicle or engine having to bear any penalty or other sanction (including the denial of the right to use such vehicle or engine) under State or Federal law,
>
> then such manufacturer shall remedy such nonconformity under such warranty with the cost thereof to be borne by the manufacturer. No such warranty shall be invalid on the basis of any part used in the maintenance or repair of a vehicle or engine if such part was certified as provided under subsection (a)(2). For purposes of the warranty under this subsection, for the period after twenty-four months or twenty-four thousand miles (whichever first occurs) the term "emission control device or system" means a catalytic converter, thermal reactor, or other component installed on or in a vehicle for the sole or primary purpose of reducing vehicle emissions. Such terms shall not include those vehicle components which were in general use prior to model year 1968."

The basic meaning of the warranty is that the manufacturer will be responsible for the costs of replacement of the emission control devices or system up to 50,000 miles or 5 years whichever comes first provided that the vehicle is operated and maintained in accord with written instructions furnished by the manufacturer. In relation to the I/M program, what is particularly important is the definition of the acceptable test procedures referred to in the first paragraph of section 207(b). The basic question is what actual emissions test will be reasonably correlated with the basic standard of emission testing which is the Federal Test Procedure (FTP) used to determine if prototype vehicles and vehicles selected from the assembly line meet the applicable emission test standards under the Federal Motor Vehicle Emission Control Program (FMVCP). The purpose of this program is to ensure that cars being designed and manufactured meet the Federal emission standards. 207(b) requires that there be a reasonable correlation between the short emission test used in the I/M program with the lengthy FTP. To date five short tests have been proposed as suitable for use in light-duty vehicle and light-duty truck emission inspection programs. These include the following tests:

- the idle test
- the Federal 3 mode
- the Clayton Key mode
- the Federal Short Cycle
- the New York/New Jersey Short Cycle

These tests, then, have been proposed as being suitable for use in an I/M program to implement the warranty provisions of 207(b). An associated issue is the determination of appropriate cutpoints, that is, correct emission test standards. There are three options for developing these standards: states can determine them, or they can be provided by EPA or the manufacturers could provide the data on the basis of which standards would be set either by the states or the EPA.

PUBLIC CONVENIENCE

The general motoring public is likely to view an inspection/maintenance program an an inconvenience, yet another requirement imposed upon private citizens by the state. Without properly designed public relations programs, I/M is likely to be unpopular. In Arizona, the program was very nearly repealed in public referendum for this very reason. As a result, an I/M program must be designed so as to inconvenience the public as little as possible. There are major tradeoffs, however, between public convenience and program cost, which is ultimately reflected in the inspection fee charged. Since this inspection fee is probably the most objectionable aspect of the program in the public's mind, program planners are obliged to weigh carefully the additional expense involved in policies designed to make the program more convenient. Convience can be promoted in a variety of different ways, among which are the following:

1. Contractor facilities should be placed in locations which maximize their accessibility to the public. Stations should be plentiful enough to be sited in or near all major population concentrations in the state to minimize the travel distance between the average vehicle owner's residence and the inspection facility.

   The procedure used to allocate facilities for the contractor inspection system derived in this study used public convenience as its primary decision location variable. In this procedure, at least one station was allocated to each county, regardless of whether locating such a station was economically warranted under the circumstances. In most rural counties, the inspection station will be located at or near the geographic center of the county, or in the county seat. This will minimize travel distance and time costs to vehicle owners; in no case will a vehicle owner be required to drive over 20 miles (or for longer than 30 minutes) to an inspection facility. While it is true that building more facilities than the number recommended would increase consumer convenience by reducing travel times, it is felt that additional facilities would increase this convenience only marginally, while adding substantially to program costs and total inspection fees.

2. Waiting lines in contractor inspection facilities should be kept to a minimum. This can be accomplished in several ways: first, test procedures should be automated to process vehicles as rapidly and accurately as possible. Second, facilities should be designed and staffed so that their capacities are sufficient to handle even peak demands. Both these factors were very important in the design of the system recommended in this study. Capacity sufficient to accommodate at least the projected 1987 inspection demand was designed into the system; a great deal of additional capacity can be added without higher capital expenditures by merely extending working hours. Finally, vehicle registration policies can be arranged so as to stagger mailings of registration materials and spread out the number of inspections processed within a given month, so that vehicles do not arrive at inspection stations in unmanageable numbers at the end of each month. At present, a system for mailing out registration materials on a monthly basis is being devised by the Bureau of Motor Vehicles at inspection stations, and avoid bunching and long waiting lines. Especially in large cities such as Cleveland, Toledo, Dayton, Akron, Columbus, Youngstown and Cincinnati, it may be necessary to assign inspections on an appointment basis to ensure that inspection stations are continuously busy, even on off-peak hours.

3. Retest policies for those vehicles which fail inspection can take a variety of different forms, some of which are more convenient from a consumer standpoint than others. The maintenance-retest cycle can be made, by policy decision, either a two-stop or a one-stop procedure. In the two-stop procedure, which is the method recommended by this study, a motorist whose vehicle fails emissions inspection would be allowed a certain time, generally between 30 and 90 days, in which to have his vehicle maintained, and then would be required to bring it back to the contractor inspection station for a free retest before the registration process could be completed. In the one-step procedure, such as that

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used in California, a motorist whose vehicle fails inspection has the option to bring the vehicle to a certified private repair facility which contains a state-approved and calibrated analyzer. At this facility, the vehicle would be maintained and retested. If its emissions were corrected to meet state standards, the owner would be given a certificate of compliance directly by the repair facility and would not be required to undergo the retest at the contractor facility.

Both of the above-described retest policies have advantages and disadvantages. The one-stop policy obviously involves less travel time and waiting time on the part of the vehicle owner, but it also involves direct involvement on the part of the state with the private automotive repair industry. State offices for licensing, regulating, certifying and regularly calibrating emission analyzers in private repair facilities would be necessary. Since thousands of private facilities would be involved, the manpower and equipment costs of such a program might be so high as to significantly affect the test fee. If this is the case, then serious equity questions arise: should the entire motoring public be made to bear the high cost of a program which benefits only those vehicles which fail inspection? The contractor system recommended by this study incorporates capacity enough to handle all retests of failed vehicles, and these retests can be performed in contractor facilities in a manner which duplicates the rigorous quality control of the original test. It is doubtful that most repair shops could afford the equipment necessary to match the quality of the contractor test procedure.

QUALITY ASSURANCE

Maintaining a high degree of precision and uniformity in emission test results is vital to the successful implementation of an inspection/maintenance program. Accurate information must be generated to correctly analyze the impact the program will have on lowering emissions from motor vehicles as well as to maintain public interest and participation in the program. If I/M is perceived as a haphazard arbitrary program, enforcement problems will become intractable.

The repeatability of the actual test procedure itself is central to the issue of quality assurance. The test must be carried out correctly and with a high degree of uniformity on all vehicles included in the program. Ohio's decision to establish a contractor-operated network of test lanes will facilitate the standardization and repeatability of tests. Such a system contains a relatively small number of high quality exhaust gas emission analyzers that can be closely monitored.

It is technically feasible and desirable to automate the testing sequence in this situation, tying all operations associated with the test into a central computer system.

The key or loaded-mode test procedure that Ohio has chosen to incorporate into its I/M program is a sophisticated test that measures vehicle exhaust emissions under a variety of different "loads" or conditions that simulate the actual emissions generated by a vehicle under normal driving conditions. To correctly perform a loaded-mode test, a series of samples must be taken from a vehicle's exhaust when it is experiencing loads within certain parameters. The results of this sampling series are integrated with each other to provide a bottom line figure regarding the engine's overall emission level.

Automating a loaded-mode test by interfacing the control of the analyzer and dynamometer with a computer routine removes a large portion of the cause of test result variability, human error. This approach to test control limits human involvement to (1) identifying the vehicle to the computer by means of entering the vehicle identification number (VIN) into an input/output device (i.e., a "CRT" or TV screen-type computer terminal), (2) manually inserting the analyzer probe into the tailpipe (or tailpipes) of the vehicle being tested, and (3) operating the vehicle on the chassis dynamometer. The computer routine can monitor the "load" being generated by the dynamometer and automatically take exhaust samples at the appropriate times. The sample results can be integrated by the computer and compared with test standards stored in the computer.

Once such a system has been installed and its software has been found accurate and reliable, a series of relatively simple checks should be made to insure its continued correct operation. Analyzers must be calibrated periodically. This procedure is straightforward. By analyzing a set of "calibration gases" that have known precisely-blended contents and checking the analyzers readings of actual gas content, the analyzers accuracy can be determined. At the very least, an exhaust gas analyzer should be checked in this fashion whenever it is turned on and adjusted if its readings are different than they should be. With an automated system, the analyzer can be calibrated regularly with frequencies of 1 hour to minimize the quantity of bad information generated as the result of any equipment malfunction.

In the contractor-operated system chosen by Ohio, periodic inspections should be made by the state to verify the accuracy of data submitted by the contractor. Ninety days is the generally accepted interval for such checks on central test lane equipment. In addition to scheduled inspections, the state may perform unannounced checks if there have been complaints about test accuracy or other indications that an analyzer has not been functioning properly.

In order for such state inspections and checks to be useful, there are certain informational requirements that should be placed on the contractor. Most important, periodic reports on the frequency and results of equipment calibrations should be mandatory. A log of any adjustments made in the process of calibrating equipment should also be kept. Experience to date shows that the operation of automated test systems is relatively trouble free, and that downtime resulting from equipment malfunction is minimal. In addition to direct equipment maintenance and calibration records, there are a number of items that should be recorded to provide data for use in analyzing the effectiveness of the program. This subject is dealt with in the section of this report concerned with legislative aspects of implementing I/M.

Another quality assurance issue that should be handled legally in program enabling legislation is the provision of a clause that prohibits the contractor from engaging in any other type of business that leads to a conflict of interest. The contractor must not be in a position to profit from one test result, but not another. This issue is discussed more completely in the section on enabling legislation that appears elsewhere in this report.

Standards should be set regarding the type of analyzing equipment that may be used by the contractor. There is a wide range in the quality and capacity of such equipment on the market today. Use of equipment that is inappropriate to a centralized network type application could provide a very low level of test accuracy and uniformity between tests. Ohio can establish equipment performance standards in one of two fashions. First, a list of approved equipment, by manufacturer and model type can be compiled. Alternately, the actual specifications and tolerances that acceptable equipment must meet may be promulgated.

There are a number of performance parameters that should be specified to insure that only high quality equipment is used. Most obviously, the accuracy (in plus or minus percent) of the actual hydrocarbon and carbon monoxide readings must be specified. The consistency of a units analysis over time should also be subject to limits. If this "zero drift" is large over time, either more frequent recalibrations should be stipulated or the unit should be kept off the approved list. The "purge time" of an exhaust gas analyzer is another important parameter. This phrase refers to the time interval that must pass between tests to assure that the units emission readings are influenced only by the exhaust of the vehicle being tested. The phrase "purge time" means how long a unit must remain unused before it has been cleansed of all gases introduced by the previous test sequence. In high speed units of the type suitable for use in the high volume contractor-operated system Ohio has chosen, an inert or "neutral" gas such as nitrogen is run through the analyzer after each test sequence to remove all traces of material introduced into the analyzers system by previous tests.

Specifications of an analyzer that is quite adequate for the applications described here are presented in Table 20. These specifications are provided for use as a guideline in selecting analyzers and are not intended to be used as "minimum" standards. This information was obtained from Horiba Instruments Incorporated, Irvine, California.

TABLE 20. GENERAL SPECIFICATIONS OF A TYPICAL I/M CENTRALIZED FACILITY EMISSION ANALYZER

Item	Specifications/Comments
Measuring Method:	NDIR, optical filter, dual source gas-filled capacitive type detector.
Sensitivity:	0.5% of full-scale analysis range
Repeatability:	±0.5% of full-scale with successive identical gas samples under the same physical conditions
Zero Drift:[*]	less than 1% of full-scale/24 hrs
Span Drift:[*]	less than 1% of full-scale/24 hrs
Response Time (electrical):[†]	0.5 to 15.5 seconds to 90% of full-scale in 120 switch selected increments
Ambient Operating Conditions:	temperatures between 0°C to 40°C humidity - less than 95% RH
Warm-Up Time:	30 minutes to full accuracy
Power Requirements:	115 VAC (±10%) 60 Hz ±0.5 Hz
Meter Accuracy:	5% of full scale
Sample Gas Flow Rate:	0.5 to 10 liters per minute
Sample Gas Inlet Pressure:	28.5 p.sig.
Interference From Co-existing Gases:	less than 1% of full scale

Minimum/Maximum Measuring Range:[‡]	Minimum	Maximum
CO (carbon monoxide)	50 ppm	100%
CH_4 (methane)	100 ppm	100%
C_3H_8 (propane)	100 ppm	100%
C_6H_{14} (n-hexane)	100 ppm	5%

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[*] Drift performance specifications are based on ambient temperature variation of less than 10°C over a 24-hour interval.

[†] Total analyzer response time is dependent on sample gas flow rate, sample cell length and electrical response time.

[‡] Minimum Recommended Measuring Range is the full-scale concentration which may be measured with a 500 mm sample cell, response time of 0.5 seconds full-scale and a noise level of less than 0.5% of full-scale.

MECHANICS TRAINING

Need for Mechanics Training

Mechanics training is a highly important part of an effective I/M program. Mechanics training may occur through a very structured government sponsored series of courses, through auto industry programs, as a regular part of vocational training courses, or informally through repair shop on-the-job training. Most government sponsored mechanics training courses include both background content, or orientation towards the basic need and benefits of I/M and the mechanic's role in the program, as well as technical content on emission systems, correct diagnosis and repair of emission systems and low emission tuneup procedures. The reason that EPA and the automotive industry has focused so much attention on mechanics training stems from two basic reasons. One is the increasing technical complexity of automobile emissions control systems. Due to the growing complexity not only of the emissions controls but the overall technical sophistication in the basic electrical ignition, and carburetion systems, and the use of electronic devices and power systems, there is an ever accelerating need for constant training and retraining of mechanics. In recognition of this automobile manufacturers have themselves instituted in service training programs for mechanics.

The second basic reason for needing mechanics training relates to the employment situation in the automobile repair industry itself and public attitude towards it. Due to skill shortages, relatively high employee turnover rates, the growing complexity of the motor vehicles and repair shops, it is generally felt that there are widespread substandard and unethical repair practices in the repair industry. In the past few years there has been much publicity on consumer dissatisfaction with the quality of service experienced throughout the repair industry. In response to this general dissatisfaction, there have been proposals to have more stringent regulation of the repair industry such as licensing or certification of repair facilities or mechanics. The potential effects of such regulations has been debated widely and most industry spokespersons oppose overly stringent controls because they would seem to restrict competition. Mechanic training seems to be a sound alternative to licensing or other forms of direct regulation of the repair industry.

A related development of major concern to the I/M program itself is the widespread practices of vehicle owners tampering with their emissions controls and fuel switching. Misunderstanding on the part of both the public and the auto service industry on the technical aspects of emission controls and the relationships between emissions control, fuel economy, and performance have encouraged these practices. U.S. EPA has stated that 35 percent of 1976 and 1977 model cars have had their emission systems tampered with in some way, ranging from minor adjustments away from manufacturer specifications to major, sophisticated disconnections or retoolings.[1] At a recent emission control conference, Mort Schultz, the editor of "Car Clinic" in Popular Mechanics Magazine stated that he receives scores of letters from individual car owners asking how to disconnect their emission control equipment.[2] Twenty percent of the letters that Mr. Schultz receives deal with emission control or related problems. The letters express fear, misunderstanding, unhappiness and disgruntledness. In many cases auto mechanics both in small shops and in dealers encouraged tampering or were unable to fix problems that related to emission control system problems. Among the solutions to these problems, according to Mr. Schultz, was "better mechanic orientation. The mechanic at the grass roots level can be the best emissary or the worst enemy. If he or she is convinced that emissions control is necessary than he or she can convince the consumer."[3]

Benefits of Mechanics Training

The benefits of mechanics training may readily be seen from the above analysis of the needs for mechanics training: better understanding of the need for emission tuneups and repairs, a more positive attitude towards emissions reduction and I/M program, higher quality emission repairs and tuneups, fewer consumer complaints about emission repairs, reductions in illegal tampering and fuel switching, and a generally better relationship between the auto repair industry and the public. In conjunction with mechanics training a comprehensive public education program is, of course, needed to ensure that the public at large does not encourage or contribute to unethical practices such as tampering that reduce the overall effectiveness of mechanics training programs in particular and the I/M effort in general.

Approaches to Mechanics Training

A variety of approaches have been instituted for mechanics training in various states, ranging from very comprehensive government-sponsored programs to informal industry sponsored efforts. In this discussion, the emphasis will be on providing an understanding of the range of methods that could be employed in Ohio.

Mechanics Training Courses--

Many states have instituted a formal, structured mechanics training program in conjunction with the implementation of their I/M programs. In terms of the actual timing of these courses, it is important to begin training mechanics several months to a year before the mandatory inspection process begins. However, the difficulty in emplementing early training programs relates to the fact that attendance is voluntary. Consequently, there must be an incentive to participate. The primary incentives are, first, government requirements for the official certification of a repair shop that it employ at least one mechanic who has completed an approved mechanics training course and second, the economic incentive to the repair facilities and mechanics that result from the certification process. The repair shops that meet the certification requirements can increase their repair business and this serves as a significant incentive to other shops and mechanics to join the program. Obviously, as the I/M program becomes operational and repair demand grows, so does the demand for mechanics training. The more formal government sponsored programs are held in a classroom setting at local vocational schools or community colleges. Typically, such courses may be held in the evenings and last for 12 total hours. Subject matter includes basic orientation to the needs and benefits of I/M and the role of emission tuneup personnel in the I/M program and familiarization with basic emission control equipment and emission control tuneups. "Hands-on" experience is important. Ten instructors for such programs have already been trained for this through the Colorado State University emission instructor program. These master teachers are available to train local vocational education instructors; and to conduct adult education courses for those mechanics already in the field.

On-the-Job Training--

Another approach to be considered which was found useful in Arizona's program, is the on-the-job training. Special two-person instructor teams may hold courses at local repair facilities, training mechanics from nearby shops. This approach emphasizes practical experience and overcomes the problem of reaching mechanics who are unable to take the time off to attend classroom courses.

Automomobile Industry Courses--

In addition to government sponsored I/M program mechanics training courses, it is important to consider industry sponsored efforts and resources. General Motors Training Centers are available in many metropolitan areas. These centers regularly hold special emission control repair and tuneup courses for GM equipment at no charge to the mechanics. Some dealers send mechanics regularly to these centers to update their knowledge and skills to keep abreast with the rapidly changing technologies. The other major automobile manufacturers also offer training opportunities, although not as extensive as those from GM. Manufacturers, both domestic and foreign, may send instructors to dealers or localities with mobile vans and conduct mechanics training upon request from local car dealers.

Vocational Education Courses--

Another important resource is the statewide vocational education school system. Regular mechanics training courses of longer duration than those described above, are held for students seeking basic automobile mechanic skills. These courses should receive continuous update of the new technologies and skills so that students graduating from them are competent to do emission control repair and tuneup practices. Most of the instructors trained through the Colorado State University program have already incorporated this emission information into their ongoing mechanics classes. This should assure that new mechanics entering the trade will have a substantial emissions background, thus enabling the repair industry to handle the increased repairs due to I/M and the more complex technology of today's vehicles.

An important footnote to the mechanics training approaches noted above is that, no matter what approach(es) are used, there is a constant need to update both the instructors and the students on a regular basis. As the automotive technology grows, short courses which incorporate the new aspects of the motor vehicle industry should be offered as often as possible.

Cost Estimates for Mechanic/Investigator Training

Estimates were derived for training costs for mechanic training instructors, inspectors for the centralized lanes, state investigators for consumer complaints and quality assurance, and mechanics in the private repair facilities. These estimates are shown in Table 21. The figures were compiled from the experience of Colorado State University in this field, as well as contact with other states with mechanics training programs. Thus, for the purposes of this report, it may be assumed that a cost of $74.00, $16.00, $59.00, and $22.00 will cover the training of one instructor, inspector, investigator, and inspector/mechanic respectively. The mechanic training course assumes a classroom instruction period of 12 hours; it includes use of teaching materials such as workbooks and slides as well as hands-on experience. Also, these courses would be paid for by the state in order to encourage maximum participation.

Estimated Number of Inspector/Mechanics Needed--

The total number of possible repair stations in 1970 for the State of Ohio is 9600. This includes 1300 dealers, 2800 repair shops, and 5500 service stations. If a 25 percent, 50 percent, and 75 percent participation rate for these stations is used, a range of costs for training may be obtained. This method will help assure that a fairly accurate cost is derived, given the unpredictible market participation.

Table 22 shows the estimated cost of training mechanics for the State of Ohio. It should be noted that this cost does not include the purchase of approved analyzers which repair stations would need, but rather, a rental fee. Also, in actuality, some stations would not participate, thus having zero mechanics trained, while others would have more than one. It should also be remembered that the total number of stations used for calculation (9600) includes those stations selling gasoline only (with no mechanics), and speciality repair shops. Also of note is the fact that the $22.00 cost may vary as to the method and extent of instruction required. Finally, it may be decided that more or less mechanics be trained, instead of an average of one per station.

From Table 22, an average cost, assuming a 50 percent participation rate from repair stations, is $105,600. This would be an initial training cost. An annual cost would have to also include update training. The cost for this, as well as for adjunctive training programs must be decided as the state enters its I/M program.

PUBLIC INFORMATION PROGRAM

Experience in several states that recently established inspection/maintenance programs emphasize the importance of an effective public information program. A well-designed, comprehensive program that introduces the public to the basic need for, and benefits of, I/M and clarifies the misunderstandings that surround I/M is critical during the early stages of implementation. A well-thought-out program can help eliminate potentially adverse reactions that other states with inadequate public relations programs have experienced (e.g., Arizona, Cincinnati, and Chicago).

A comprehensive public information program should consist of three basic phases: (1) early initial public education on the basic need and benefits of I/M; (2) and intensive public relationship effort 6 months prior to the actual beginning of mandatory inspection; and (3) an ongoing public information program.

TABLE 21. ESTIMATED INSTRUCTION COST FOR INSTRUCTOR, INVESTIGATOR, AND INSPECTOR/MECHANIC TRAINING[*]

Expenditure items	Training level			
	Inspector[‡] ($)	Instructor[†] ($)	Investigator[†] ($)	Inspector/ mechanic[‡] ($)
Rent, insurance, utilities	12	150	150	45
Equipment	50	150	150	60
Teaching supplies	110	120	120	110
Instructor	100	900	600	180
Clerical	50	160	160	50
Total	322	1,480	1,180	445
Cost per person	16	74	59	22

[*] High Altitude Vehicular Emission Control Program, Volume VIII. Pilot Training Program Results for Motor Vehicle Emission Control, Supplement II. August 1976. Colorado State University and GCA estimates.

[†] 40-hours of training

[‡] 12-hours of training

(continued)

TABLE 21 (continued).

ASSUMPTIONS:

- There are 20 students per class.
- There is one instructor per class, except where instructors are teaching instructors. Here, the recommended student/teacher ratio is 12:1; so the indicated cost is for 1.5 instructors.
- A $600.00 maximum figure is used for rent per month (this includes insurance and utilities). When this is broken down into smaller time periods, the rate is considered to be somewhat increased. If a building is owned or rent-free (as private repair stations may be), this figure would change. It is assumed that the contractor already owns the building for the costs undergone in training inspectors for the central lanes.
- The equipment cost given for the private repair stations is a cost-to-rent figure. If the equipment had already been purchased,the cost would change. It is assumed that the contractor has purchased the equipment needed. Therefore, this figure would only encompass electrical costs.
- The instructor cost for the contractor is the cost of a mananger's time.
- For the contractor, it is assumed that one lane would be used, and safety and emissions testing would be taught.
- The teaching supplies are Colorado State University material, and would vary according to what has already been purchased by those in this field in Ohio.
- The clerical costs will vary according to the extent of records kept as well as whether a testing system is used.

TABLE 22. ESTIMATED COST OF TRAINING INSPECTOR/MECHANICS

Participation	Number of stations	Training cost ($)*
25%	2400	52,800
50%	4800	105,600
75%	7200	158,400

*Cost to train one mechanic per station at $22.00 per mechanic.

Phase I: Initial Public Information Program

The emphasis of this phase, which should begin in the early planning and design stages, should be in basic education as to the needs for I/M, the benefits of I/M, and what it means to the public. It is very useful that the public begin to gain a familiarity with the I/M concept and that this concept have time to grow in the public awareness. The first stage occurs during the period prior to introducing the legislation to the state legislature, and extends through the time that the legislation is approved. The purpose is to inform the public about the need and benefits of the program primarily to develop support from people whose representatives will be acting on the legislation in the state legislature. The effort is often focused on organized groups who have lobbying power and an interest in promoting clean air. The elements of this phase would consist of a slide presentation, mobile emission testing display, a generalized brochure, and press releases. The slide presentation can be given to such interest groups as clean air groups, environmental groups and conservation clubs, the League of Women Voters, automobile clubs, automobile service industry groups, and local civic or service clubs. Also, metropolitan and regional planning agencies can be involved at this point. A mobile emissions test demonstration van has been found useful to acquaint the public or special groups with the inspection process. Many states have prepared brochures explaining I/M and distributed them widely among the general public. As important decisions are made and implementation begins, periodic press releases should be made. This initial public information effort may be accomplished by the state itself or through assistance provided by private organizations with experience in I/M public relations programs. Some states have contracted with the local clean air or lung association.

Ohio has already begun Phase I. The Ohio Environmental Protection Agency has made press releases and TV announcements discussing the planning efforts on I/M and agency discussions regarding the selection of the option being considered in this report. A letter has been sent out to locally select officials and concerned citizens groups explaining the needs, benefits, and major elements of I/M programs. During August 1978 OEPA had an exhibit at the Ohio State Fair that demonstrated emission control systems and an emission analyzer. The demonstration van, which was put together by Colorado State University, and funded by U.S. EPA, consisted of an automobile engine with controls to modify the basic engine adjustment parameters and an emission analyzer that showed the changed emission levels resulting from adjustments made to the carburator, ignition, or emissions controls. Also, OEPA has conducted meetings to explain I/M and gain input from the public.

Phase II: Preinspection Public Information

About 6 months prior to the opening of test lanes for mandatory testing with voluntary maintenance, there should be an intensive public information effort. During this time every motorist must be informed of the needs and benefits of I/M and also of his obligations and rights and the basic organization and procedures in the program. Also, this is the period during which the training of the inspectors, in the contractor lanes would occur. An important part of the training is dealing effectively and courteously with the public.

The basic elements of Phase II public information would be a mailing to each motorist, inspector training, news releases and media advertizing. The mailing would consist of a pamphlet not only explaining the basic reasons for having I/M and the benefits such as air quality and fuel economy improvements but also the times and places of the inspection stations operation, what consumer rights and obligations are, what the complaint procedures are, and also important details of the maintenance phase. During this phase, media advertisements or announcements are important because it is critical that every affected motorist receives the right information. All the employees of both the state and the contractor who deal directly with the public especially the emission inspectors, station managers, hotline operators, complaints investigators, and calibration officials should receive training in how to deal with the public and an understanding of the basics of I/M. The State of Ohio will handle startup phases of public information until such time as the contractor is chosen. At this point, the contractor will take over this function, although the state will maintain overall supervision.

Phase III. Ongoing Public Information

The emphasis in the ongoing public information program is largely informational. States with existing I/M programs such as New Jersey and Arizona have indicated that as the public becomes used to the program there is less and less of a need to conduct public information. There would still be a need to inform motorists of any significant changes in program operations or other modifications of program elements such as waivers, exemptions, repair cost ceiling, inspection fees, or registration procedures. This would entail periodic mailing and possibly some media announcements. Also, new employees who deal with the public would be required to receive the same orientation that the initial personnel received at the beginning of the program. These tasks will be handled mainly by the contractor, although it is expected that the state will take on the usual public information procedure used when undertaking any new program.

Although the contractor will handle much of this phase of the public information program, the state will maintain close supervision.

PROGRAM ENFORCEMENT CONSIDERATIONS

EPA policy states that all I/M programs must "prohibit registration or provide some equally effective mechanism to prevent vehicles which do not comply with the applicable exhaust emission requirements from operating on the public roads". Nearly all the states having I/M programs utilize the registration prohibition as the primary enforcement mechanism. This procedure can guarantee the maximum compliance level because registration is a legal prerequisite to vehicle operation. Other methods of enforcement especially using stickers and ticketing noncompliance vehicles have also been used. Rhode Island, which has utilized sticker/ticketing for many years as the main enforcement procedure for the safety inspection program, has found sticker/ticketing to be effective. However, one of the main reasons for not adopting the registration procedures was the difficulty in changing the registration system to fit with the staggered inspection time framework. Due to the controversial nature of the emission inspection program, and the expenses in the ticketing and levying of fines, it is very likely that sticker/ticketing would be far more costly than using the registration procedure for the primary enforcement mechanism. Also, there is no guarantee that without a very vigorous, comprehensive enforcement campaign that sticker/ticketing could bring the same level of effectiveness or compliance. Enforcement is also discussed in Section 1 Legislative Considerations.

Motor Vehicle Registration Enforcement Procedure

By January 1, 1980 the Ohio Bureau of Motor Vehicles will have implemented an annual staggered motor vehicle registration system. Registrations will be fairly evenly distributed according to the first letter of the last name. Applications for renewal will be mailed out to the public sufficiently in advance of the expiration of the last registration so as to allow time for the motorist to go through the I/M procedure. In order for the registration to be valid, a motorist will have to obtain from the inspection station a certificate of compliance. A certificate of compliance will be issued when the motorist passes the emissions test and according to Ohio EPA will be valid for 90 days. This gives more than adequate time for maintenance and reinspection maintenance if needed. After obtaining the certification of compliance a motorist has the choice of mailing in his registration renewal with the certificate of compliance to Columbus or of taking them to the local deputy registrars. (There are over 800 deputy registrars in Ohio.) Thus, the registration procedure would be fundamentally linked to the I/M program through the certificate of compliance.

In addition to the annual registrations there would be initial registrations for the purchase of new or used vehicles and for people coming in from out of state. The procedures for these categories would be similar to the annual registration renewal. In the case of the purchase of a vehicle, new or used, the owner would be issued a temporary registration that would be valid for a certain period of time, say 30 days. During this period he would have the car inspected and then, upon passing the emission test, obtain the certificate of compliance. He would then apply for the regular registration. When a person is moving into Ohio from out of state, he would be allowed a certain time to obtain a certificate of compliance from the inspecting station and then obtain a registration from the nearest deputy registrar.

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SECTION 7

LEGISLATIVE CONSIDERATIONS

INTRODUCTION

The purpose of this section is to analyze the issues that must be addressed by Ohio in the legislation that establishes the inspection/maintenance program. The actual legislation developed is instrumental to the success of the program in that it establishes the basic program framework, defines basic rules and regulations and administrative duties, and designates authority to operate the program. As such, the legislation must be broad enough to encompass all the necessary program elements and responsibilities, and yet have sufficient flexibility as to allow for necessary changes in the program over time as required by changing economic, political or other conditions.

APPROACH AND METHODOLOGY

The basic approach used in analyzing the legislative issues and requirements was to review all pertinent literature and documentation, and to analyze legislation from several other states where I/M bills have been successfully drafted. In connection with the basic literature review, the most relevant information is contained in various guidance documents and policy statements issued by the U.S. Environmental Protection Agency. The intent here is to define various technical and administrative requirements related to I/M legislation that apply in a general sense to any state where I/M is required by virtue of the 1977 Amendments to the Clean Air Act. It is important to note, however, that a complete discussion of the legislative issues and requirements for the state would have to consider existing statutes and legal requirements for preparing legislation that are specific to Ohio. This level of analysis would more appropriately be undertaken through a joint effort among various state agencies and members of the State Legislature and their staffs.

LEGISLATIVE ISSUES

A number of issues relevant to I/M legislation were identified during the literature review. The following paragraphs present a discussion of these issues both in general terms, and in connection with specific legislation written in other states. The issues discussed include:

1. Authority to Implement I/M
2. Definitions
3. Authority to Establish Emission Test Standards
4. Authority to Grant Waivers and Exemptions
5. Authority to Contract with Private Contractors
6. Authority to Oversee Private Contractor
7. Enforcement and Penalties
8. Conflict of Interest Prohibition
9. Designation of Lead Agency and Other Agency Responsibilities
10. Licensing of Inspectors
11. Program Coverage
12. Vehicle Coverage
13. Inspection Frequency
14. Retest Policy
15. Repair Cost Limits
16. Fleet Inspections
17. Tampering
18. Documentation of Repairs Performed
19. Fees
20. Program Commencement and Phase-in Dates
21. Funding
22. Length of Program
23. Data Collection and Studies
24. Mechanics Training
25. Public Information Program

Authority to Implement I/M and Statement of Purpose

The basic statutory authority to implement an I/M program is stated in one or several sections of the I/M enabling legislation. Often in the section designating the responsibilities of the lead agency and other cooperating agencies the basic authority to implement and conduct the program is stated. Also, the authority to conduct various elements or tasks of the program such as to establish emission test standards, grant waivers and exemptions, to contract and oversee contractor responsibilities, to conduct enforcement and apply sanctions or penalties are all stipulated under various specific sections of the legislation. These specific issues are discussed below.

The statement of the basic intent and purpose including legislative findings of the need for the I/M program may be included at the beginning of the

I/M legislation. The inclusion of this section, which may be called a preamble, may depend on whether or not the enabling legislation is the first statute to introduce an inspection program for automobiles. An example of a preamble taken from a U.S. EPA model I/M bill is provided below:

> MODEL LEGISLATION FOR MOTOR VEHICLE POLLUTION CONTROL
>
> "Purpose
>
> Legislative Findings: For purposes of public health and safety, the _________ finds:
>
> (1) That the emission of pollutants from motor vehicles is a significant cause of air pollution in many sections of the State of _________.
>
> (2) That the control and elimination of such pollutants are of utmost importance for the protection and preservation of the public health, safety and well-being.
>
> (3) That each state has a responsibility to establish procedures, regulations and other provisions which comply with any promulgated federal laws to control or eliminate such pollutants.
>
> The state Environmental Agency and all other agencies, departments or divisions of said departments and agencies shall provide by rules and regulations standards, guidelines, for the inspection of all registered vehicles (with promulgated exceptions) in said state, for the purpose of controlling exhaust emissions of any air contaminants."

Definitions

Typically, a separate section of the I/M legislation is provided specifically to define important words, and phrases used in the text of the legislation. As is the case in any law, having clear, unambiguous meanings is essential in order to avoid legal problems, misinterpretation, or unnecessary conflicts among agencies, individual citizens, or private groups with interests in the program. Some I/M legislation defines the key terms in the body of the text but most begin the law with a definitions section to establish clarity at the outset. Following is the definitions section from the New Jersey State Department of Environmental Protection Air Pollution Control Code, Chapter 15, Control and Prohibition of Air Pollution from Light-Duty Gasoline-Fueled Motor Vehicles, January 6, 1972:

> "Section 1 - Definitions
>
> 1.1 PERSON: Includes corporations, companies, associations, societies, firms, partnerships and joint stock companies as well as individuals, and shall also include all political subdivisions of this State or any agencies or instrumentalities thereof.
>
> 1.2 MOTOR VEHICLE: Includes all vehicles propelled otherwise than by muscular power, excepting such vehicles as run only upon rails or tracks.

1.3 LIGHT-DUTY: Light-duty shall mean any motor vehicle designed primarily for transportation of persons or property and registered at 6,000 pounds gross weight or less.

1.4 MODEL YEAR OF VEHICLE: The production period of new motor vehicles or new motor vehicle engines designated by the calendar year in which such period ends. If the manufacturer does not designate a production period, the model year with respect to such vehicles or engines shall mean the 12-month period beginning January of the year in which production begins.

1.5 EXHAUST EMISSIONS: Substances emitted into the atmosphere from any opening downstream from the exhaust ports of a motor vehicle engine.

1.6 CRANKCASE EMISSIONS: Substances emitted into the atmosphere from any portion of the engine crankcase ventilation or lubrication systems.

1.7 SMOKE: Small gasborne and airborne particles, exclusive of water vapor, arising from a process of combustion in sufficient number to be observable.

1.8 CARBON MONOXIDE: A nonirritating, colorless, odorless gas at standard conditions which has the molecular form of CO.

1.9 HYDROCARBONS: Compounds whose molecules consist of atoms of hydrogen and carbon only.

1.10 APPROVED EXHAUST GAS ANALYTICAL SYSTEM: A device for sensing the amount of air contaminants in the exhaust emissions of a motor vehicle. For purposes of this Chapter this shall mean analyzing devices of the nondispersive infrared type sensitized to measure carbon monoxide at the 4.74 micron band expressed as percent carbon monoxide in air and to measure hydrocarbons as hexane at the 3.41 micron band expressed as parts per million of hydrocarbons (Hexane) in air. The device shall be a design meeting "SPECIFICATIONS FOR EXHAUST GAS ANALYTICAL SYSTEM" on file with the State Commissioner of Environmental Protection and approved for use in accordance with the manufacturer's recommended procedures for calibration and maintenance.

1.11 NEW MOTOR VEHICLE: A newly manufactured motor vehicle registered in New Jersey, prior to delivery to the ultimate purchaser.

1.12 NEW MOTOR VEHICLE DEALER: A sales agency, his employees, and/or agents licensed pursuant to N.J.S.A. 39:10-19 to sell new motor vehicles.

1.13 ULTIMATE PURCHASER: Any person, other than a motor vehicle dealer purchasing in his capacity as a motor vehicle dealer, who in good faith purchases a motor vehicle for purposes other than for resale as a motor vehicle dealer.

1.14 PREDELIVERY CHECKLIST: A schedule of items and procedures which a new motor vehicle dealer is required or requested by a manufacturer to check or follow prior to delivery of a new motor vehicle to the ultimate purchaser."

Authority to Establish Emission Test Standards

The success of an I/M program rests largely on the manner in which the maximum allowable emissions levels for vehicles are set. To achieve maximum emission reduction benefits while minimizing consumer inconvenience, several states are using standards or cutpoints that are specific to the type and model year of the vehicle. While it does increase in the complexity of certain aspects of the test procedure, it also ensures that the program is equitable in the sense that older, less well-controlled vehicles would not be tested against the same standard than newer, better controlled vehicles would be.

A draft of sample I/M legislation prepared by the EPA in 1976 indicates the types of variations in standards as a function of vehicle model year that would be reasonable for both idle and loaded mode testing; standards for idle tests are presented in Table 23 below.

TABLE 23. SAMPLE CUTPOINTS DEFINED AS A FUNCTION OF MODEL YEAR FOR THE IDLE MODE TEST

Model year	Maximum allowable	
	HC (ppm)	CO (%)
Pre-1968	1000	6.0
1968-69	600	5.0
1970-74	500	4.0
Post-1974	150	1.5

The EPA sample for loaded mode emission level standards is presented in a similar, but more detailed table (not included here).

The actual authority to establish cutpoints should rest with the agency administering the I/M program. The following quote from chapter 1154, Section 2, 39118 of the California Health and Safety Code illustrates this.

> "39118. With respect to the program designed and adopted by the Department of Consumer Affairs pursuant to Chapter 20.4 (commencing with Section 91889.50) of Division 3 of the Business and Professions Code, the board shall, in time for the Department of Consumer Affairs to comply with the schedule specified in subdivisions (a) and (b) of Section 9889.55, after public hearings, prescribe maximum air pollution emission standards to be applied in inspecting motor vehicles. In prescribing such standards, the board shall undertake such studies and experiments as are necessary and feasible, evaluate available data, and confer with automotive engineers. The standards shall be set at a level reasonably achievable for each

> class and model of motor vehicle when operating in a reasonably sound mechanical condition, allowing for the effects of installed emission control equipment and devices, and the motor vehicle's age and total mileage. The standards shall be designed to secure the operation of all such motor vehicles, as soon as possible, with a substantial reduction in air pollution emissions, and shall be revised from time-to-time, as experience justifies."

Section 36-1772, Part E of the Arizona Revised Statutes (ARS), Section R9-3-10063 states:

> "The director (of the Department of Health Services) shall adopt minimum emissions standards pursuant to Section 36-1717 with which the various classes of vehicles shall be required to comply after January 1, 1977. R9-3-1006 of ARS titled "The Mandatory Vehicular Emissions Inspection" states in Subsection E that "All tested vehicles must meet exhaust emissions standards as established in this subsection when their exhaust emissions are inspected under the conditions as prescribed in Subsection B of this section. Any vehicles that do not meet their prescribed standard shall fail their exhaust emission inspection." Subsection I then establishes emission standards based on a variety of factors.

It is important to empower the program administrator with the authority to set and revise the emission standards. There is an important balance between the emission standard and resulting failure level. As standards become more stringent, the failure levels increase. Because over a certain failure level there is only a marginal reduction in emission it is important to have the flexibility in setting the standards so as to maximize emission reductions and minimize overly high failure levels. A very high failure level could create a significant political backlash and jeopardize the program.

Power to Grant Exemptions/Waivers

The agency administering the I/M program should be empowered to establish exemptions for certain vehicle classes and grant waivers to specific vehicles under certain circumstances. Exemptions should be established based on equity considerations (vehicle age, repair cost, etc.), and practicality (i.e., vehicles that present difficulties in performing emissions inspections). The following list is representative, but not all inclusive, of exemption categories established by programs currently in force:

- Vehicle age
- Vehicles temporarily or permanently out of use and on private property.
- Failed vehicles that have undergone required repairs but are still out of compliance.

- Permanent four wheel drive vehicles (these vehicles cannot be tested with a loaded mode system).

- Vehicles with engine displacements less than a specified minimum.

- Special purpose vehicles such as prototypes, experimental models, etc.

- Motorcycles.

The power to grant waivers is important also. If one make of a certain model year cannot meet the emission levels established for that model year, it may prove more advantageous from the point of emission reductions to allow that make/model year vehicle to remain out of compliance rather than, for instance, lowering the standards to accommodate that vehicle.

Minnesota, for example, has stipulated that after consultation with the Commissioner of Public Safety the pollution control agency "shall exempt by rule, from all or any part of the mandatory periodic inspection," (a) motor vehicles registered as classic, pioneer, or collector, pursuant to Minnesota Statutes, Section 168.10; (b) motor vehicles used for racing or other exhibition purposes at places other than on public highways of the State and not generally operated under their own power upon any public highways; and (c) any class of motor vehicle which presents prohibitive inspection problems."

Arizona provides for "H.2. The exemption from inspection of (a) vehicles which are temporarily or permanently immobilized and placed on privately-owned lands; (b) a motor vehicle over 15 years old; (c) new vehicles originally registered at time of initial retail sale and titling in this state pursuant to Section 28-302."

Power to Contract With Private Firms

The agency designated to administer an I/M program must be empowered to enter into a contractual agreement with an independent firm that will conduct the actual inspections. The wording of this phrase can be straightforward. A few examples follow:

Minnesota:

"Sec. 4. (Inspection Stations) Subdivision 1. (Establishment of Inspection Stations, Contractor.) The agency, after consultation with the Commissioner, shall determine the appropriate number and geographic distribution of inspection facilities required to implement the motor vehicle inspection program and shall contract with a public or private entity to design, implement, construct, and operate the inspection program established by this act."

Arizona: (Chapter 158, House Bill 2319

"36-1775. Agreement with independent contractor; qualifications of contractor; agreement provisions.

A. The Director is authorized to enter into an emissions inspection agreement with one or more independent contractors subject to public bidding, to provide for the construction, equipment, establishment, maintenance and operation of an official emissions inspection stations in such numbers and locations as may be required to provide vehicle owners reasonably convenient access to inspection facilities for the purpose of obtaining compliance with this article and the rules and regulations adopted pursuant hereto."

Authority to Oversee Contractor

It is important that Ohio maintain authority to oversee the activities of the contractor charged with operating the I/M inspection facility network. Ohio should retain the authority to determine what data the contractor must collect and maintain and in what format it should be reported to the state (see 'Data Collection,' below).

Title 36, Chapter 14, Arizona Revised Statutes (ARS) Article 3, part 5-1775 deals with provisions in the agreement that the state may enter into or with a private contractor. Part D, sections 3 through 6 assure that the State will have sufficient authority to knowledgably oversee the contractor's operations. It states that, among other provisions, the agreement shall deal with, "3. The minimum requirements for adequate staff, equipment, management and hours and place of operation of official emissions inspection stations. 4. The submission of such reports and documentation concerning the operation of official emissions inspection stations as the director may require. 5. Surveillance by the Department of Health Services to ensure compliance with vehicular emissions standards, procedures, rules, regulations and laws. 6. Any other provision deemed necessary by the Director for the administration or enforcement of the emissions inspection agreement."

Enforcement and Penalties

The legislation must include mechanisms to ensure that the motor vehicles covered by the I/M program comply with the regulations. EPA policy states that all I/M programs must "prohibit registration or provide some equally effective mechanism to prevent vehicles which do not comply with the applicable exhaust emission requirements from operating on the public roads." Nearly all the states that are currently operating I/M programs utilize the registration procedure as the primary enforcement mechanism although other enforcement methods, such as the use of inspection stickers, are considered to be applicable.

Arizona utilizes an enforcement procedure that requires a vehicle owner to obtain evidence of I/M compliance and present it when he applies for a renewal or new vehicle registration. R9-3-1007 of the Arizona Department of Health Services (DMS) rules and regulations states: "Evidence of meeting state inspection requirements.

The evidence that a vehicle has met the State's inspection requirements shall be attested at the county assessor's office in one of the following manners:

A. Persons applying for renewal of registration shall provide either of the following documents:

1. An Arizona card for the vehicle with all its carbon copies attached and with a pass mark (for the emissions level test) affixed as specified in Section R9-3-1010 or,

2. A completed certificate of inspection for a vehicle that is part of a fleet qualifying under Sections R9-3-1019 and R9-3-1020.

B. Applicable vehicles sold by a holder of a fleet station permit and applying for transfer of title and registration shall provide any of the two following documents:

1. An Arizona certificate of title accompanied by a completed certificate of inspection.

2. A certificate of waiver.

C. Applicable vehicles with previous registrations that are being registered in Arizona for the first time and are being registered in Maricopa or Pima County by a person other than a holder of a fleet station permit shall provide a certificate of admittance with a pass mark affixed.

D. Applicable vehicles with previous registrations that are being registered in Arizona for the first time and are being registered in Maricopa or Pima County for a holder fleet station permit shall provide a completed certificate of inspection.

E. Vehicles that are receiving registration or title changes under any other circumstances other than described in this article shall not be required to show evidence of meeting the state's inspection requirements.

F. The county assessor shall ensure that each certificate of inspection accepted as evidence of meeting the inspection requirements of this article properly indicates whether the inspection was for the purpose of acquiring a new title or renewing registration."

In addition to the denial of registration for vehicles not in compliance with the basic requirement of having passed the emission test, there may be penalties or other sanctions for falsification of compliance forms, stickers, waiver forms, or other acts, the intent of which is to avoid compliance. The Colorado law, Section 42-4-315 states: "Penalties for false certificate and no certificate (of compliance). (1) No person shall make, issue, or knowingly use any imitation or deceptively similar or counterfeit certificate of emissions inspection."

In the Minnesota legislation the following penalties are stipulated:

"Section 9. (PENALTIES.) Subdivision 1. (a) Any employee of an official inspection station or of a fleet inspection station who certifies a motor vehicle as in compliance without having inspected its equipment and mechanisms, or who wilfully certifies a motor vehicle which has equipment and mechanism which do not meet or exceed the criteria and standards therefore, shall be guilty of a misdemeanor.

"(b) Any employee of an official inspection station who undertakes to furnish information to, recommend, suggest, or designate to a motor vehicle owner or operator, or any other person connected therewith, the name or any other description of a parts or repair facility or any other place where parts, repairs, or adjustments may be obtained to bring a motor vehicle into conformance with inspection requirements, shall be guilty of a misdemeanor.

"(c) Any person who materially alters or changes any equipment or mechanisms of a motor vehicle that has been certified to comply with standards promulgated under this act, which causes the motor vehicle to be in noncompliance with the standards and criteria, shall be guilty of a misdemeanor.

"(d) Any person who provides information to an inspection station on the extent or cost of repairs done to bring a motor vehicle into compliance with the standards promulgated under this act, when such repairs were not undertaken or when the cost was not as represented, shall be guilty of a misdemeanor."

Conflict of Interest Prohibition

It is essential for consumer protection purposes that the state be prohibited from entering into a contract with an entity that stands to profit from the outcome of emissions inspections tests. Businesses that buy, sell, maintain, or repair vehicles, or that sell repair parts are particularly prohibited in most legislation.

In Section 4 again, Minnesota admonishes, "The agency shall not contract with any person who is engaged in the business of selling, maintaining, or repairing motor vehicles or selling motor vehicle replacement or repair parts at retail in this State, except that the contractor may repair any motor vehicle owned or operated by the contractor." Subdivision 2 (repairs) states, "The word 'inspection' as used in this section shall not include repairs and adjustments. Repairs or adjustments necessary to bring a motor vehicle into conformance with the criteria and standards under this act shall be the responsibility of the motor vehicle owner and may be made by the owner or any repair facility of his choosing."

A potential enabling act in Connecticut states in Section 4(b) that, "the Commissioner of Motor Vehicles and the Commissioner of Environmental Protection are prohibited from entering into an inspection agreement with any independent contractor who: (1) is engaged in the business of maintaining or repairing vehicles in this state, except that the independent contractor shall not be precluded from maintaining or repairing any vehicle owned or operated by the independent contractor. (ii) Does not have capability, resources or technical and management skill to adequately conduct, equip, operate and maintain a sufficient number of official inspection stations to meet the demand for inspection of every vehicle which is required to be submitted for inspection pursuant to this act."

Designated Lead Agency

The lead agency should be designated in the program's enabling legislation. In addition to establishing the lead agency several states (California, Colorado, Nevada, New Jersey) have named the Department of Motor Vehicles (DMV) as a cooperative agency to assist in program operation in Ohio, it is likely that the Environmental Protection Agency will assume the lead role with direct support being provided by the Bureau of Motor Vehicles.

In California Senate Bill No. 479, Chapter 1154 states: "...requires the Department of Consumer Affairs, with the cooperation of the Department of the California Highway Patrol and the (Air Resources) Board, to design and adopt a program for the mandatory periodic exhaust emission inspection of all motor vehicles registered in such counties, and prescribes specified duties in connection therewith." In August 1976 Assembly Bill No. 4161 transfered administrative control from the Department of Consumer Affairs to the State Air Resources Board.

In several statutes the lead agency is presented in the "definitions" section. The original bill that created mandatory I/M in Arizona (House Bill 2319, Chapter 158) defines "department" as the Department of Health Services (DHS) and "director" as the director of the DHS. The bill then defines duties that the director must assume; "The director shall administer a comprehensive annual emissions inspection program which shall require the inspection of vehicles in this state in accordance with the provisions of law or administrative regulations pursuant to this article."

A proposed act in Connecticut in 1976 designed to establish an I/M program states, "the Commissioner of Motor Vehicles may adopt regulations for the construction, equipping, maintenance, and operation of official inspection stations and for the enforcement of the provisions of this act. Such regulations shall provide for the efficient conduct of inspections for emissions and the presence of air pollution control devices and may include tests to determine whether the vehicle is in safe operating condition."

Licensing of Inspectors

Some state's I/M legislation may specify the requirements for licensing and/or training of the official motor vehicle emission inspectors. Other state's legislation does not include this level of detail and such specifications are then made as rules by the lead agency. The same requirements for becoming an emission inspector may be used by the state regardless of whether the state selects a contractor or state-run approval. An example of legislation concerning the licensing of inspectors is contained in the Arizona legislation which follows:

"R9-3-1016 Licensing of Inspectors:

"A. No person will be licensed as a vehicular emissions inspector unless he has demonstrated his competence to the department by such examination, training, or other standards as the director may approve.
B. Applications will be obtained from, and approved by, the department.
C. All completed applications will be returned to the department.
D. Any vehicular emissions inspector inspecting a diesel-powered vehicle as prescribed herein must have successfully completed an approved training course for visually reading opacity with the unaided eye within the last six months or must use an opacity meter that is a full-flow, direct reading, continuous reading light extinction type using a collimated light source and photoelectric cell, and is accurate within plus-or-minus 5%.
E. Licenses issued to vehicular emissions inspectors shall be renewed annually on or before December 31, except that no license shall be renewed twice in any calendar year.
F. Applications for renewal of vehicular emissions fleet inspector's licenses shall be submitted thirty days prior to the current license expiration date.
G. The department may suspend, revoke, or refuse to renew the license if an applicant has violated any applicable rule or regulation issued by the department.
H. The department may suspend, revoke, or refuse to renew the license issued to an inspector when he has intentionally failed to properly inspect a vehicle in compliance with regulations adopted by the director.
I. A vehicular emissions inspector shall inform the department of any change in his employment status within seven days of such change.
J. Each vehicular emissions inspector shall be assigned a single, unique, nontransferable inspector's number. No vehicular emissions inspector shall be assigned more than one inspector's number during his lifetime."

Program Coverage

The geographical area the program will cover should be defined specifically in the legislation. In Ohio the geographical area will be statewide. According to U.S. EPA "I/M should focus on the metropolitan areas and should include the entire urbanized area and adjacent fringe areas of development. Boundaries of the area affected may be adjusted if an equivalent emission reduction is achieved. For urbanized areas of 200,000 population or greater which need I/M to obtain of the 1982 attainment date, full mandatory I/M must be implemented by the deadlines indicated. Statewide programs are encouraged, especially for those states which are small and highly urbanized."

Arizona House Bill 2319, Chapter 158, quoted above, continues, "such inspection shall commence in counties with a population in excess of three hundred fifty thousand by January 1, 1976. Inspection in other counties of the state will commence when required by the director to meet air pollution control standards or upon application by a county board of supervisors for participation in such inspection program, subject to approval by the director."

Vehicle Coverage

In addition to defining the geographical coverage of the I/M program, the enabling legislation should specify the types of vehicles to be included in the program. U.S. EPA guidelines stipulate that all I/M programs must "provide for regular periodic inspections of all vehicles for which emission reductions are claimed." The emission reduction benefits are calculated, according to specific certain emission reduction credits defined by EPA. Credits are defined for light-duty vehicles (LDV's) and two categories of light-duty trucks. Light-duty trucks are defined as a vehicle category consisting of trucks used chiefly for personal transportation that are (generally) powered by gasoline-fueled, spark-ignited internal combustion engines. Two subcategories of light-duty trucks are used: trucks having a gross vehicle weight (GVW) in the range of 0 to 6000 pounds (LDT1), and trucks with GVW in the range of 6001 to 8500 pounds (LDT2). Trucks in these two categories are essentially all two-axle, four tire trucks. Light-duty vehicles (LDV) are primarily vehicles used for personal transportation with a GVW of up to 8500 pounds. Emission credits have not been defined for light-duty diesel trucks and heavy-duty trucks (gasoline and diesel).

Different states have defined the relevant vehicle population differently. Minnesota states that procedures shall be established "for the annual inspection of all motor vehicles registered by residents of the metropolitan area for air pollution emissions,..." "Motor vehicle means any self-propelled motor vehicle weighing less than 8500 pounds and licensed for use upon the public highways of the state for transportation of persons or property." The Minnesota statute also provides for inspection prior to initial registration for new motor vehicle sales and for inspection of vehicles owned by new residents within the area of program coverage. Regarding the latter issue, the statute states "In addition to annual inspection, a motor vehicle when first registered to a resident of the metropolitan area following a move by that person from out of the state shall be inspected for compliance with the inspection standards under this act prior to the initial registration in Minnesota."

Arizona's House bill 2319, Chapter 158 states, "Vehicles required to be inspected and registered in this State except those provided for in Section 36-1776 (a list of exemptions), shall be inspected in accordance with the provisions of this Article..." "Vehicle" means any automobile, truck, truck tractor, motor bus or any self-propelled or motor-driven vehicle registered or to be registered in this State and used upon the public highways of this State for the purpose of transporting persons or property, except implements of husbandry, road rollers or road machines temporarily operated upon the highway."

In addition to enumerating the vehicle types affected by an I/M program, vehicles that change hands must be considered. These vehicles may be new cars that are sold for the first time, used vehicles sold by dealers within the area of program coverage, used vehicles sold by dealers outside the area of program coverage, vehicles sold by one individual to another and vehicles owned by people who move their residence from outside the program's geographic coverage into it.

Existing programs treat these vehicles in fairly consistent ways. When a vehicle changes hands between individuals some states require reinspection by the new owner if it has not been inspected within 60 days prior to the sale date. Elsewhere, no specific requirement is made, that is, the vehicle must be inspected again within 30 days prior to reregistration by the new owner.

Vehicles owned by individuals can be required upon registration in one of several ways. Inspection can be required upon registration within the state for all such vehicles. Alternately, all such vehicles can enter the state without being inspected, falling under the inspection requirement prior to reregistration in the usual manner. It may be feasible to follow this policy for vehicles previously registered in an area with emissions inspection while requiring vehicles entering from jurisdictions without I/M to undergo a test and meet emission level standards within a certain time after entering Wisconsin.

The type of policy established regarding vehicles changing hands and entering the relevant vehicle population will be dictated largely by the practical problems of establishing viable enforcement measures for the policy chosen. The most practical form of enforcement is to tie I/M requirements to vehicle registration requirements (see the discussion on Enforcement).

Inspection Frequency

Generally, the more frequently a motor vehicle is inspected, the more likely it is that its emissions will approach the minimum level. Although the emission deterioration characteristics of motor vehicles vary from vehicle to vehicle and as a function of many other external factors, it has generally been found that carbon monoxide emissions tend to deteriorate back to pre-inspection levels over a period of about a year, while hydrocarbon emission rates deteriorate somewhat more quickly. EPA policy states that I/M programs must require inspections to be performed on a regular, periodic basis but does not stipulate the exact interval. From a practical standpoint a program whereby inspections are performed more frequently than annually is not desirable. Nearly all states have chosen an annual inspection cycle, which is generally integrated into the motor vehicle registration process for enforcement. Since registration in Ohio is on an annual basis, a 1-year inspection interval would be appropriate.

Most existing legislation defines the frequency of inspections in a straightforward manner. Minnesota established "procedures for the annual inspection of all motor vehicles..." Rhode Island states that "31-38-2c. Vehicles required to be inspected in this State shall be inspected at least once within each twelve (12) month period in accordance with rules and regulations established by the Registrar" (of Motor Vehicles). Other enabling legislation is worded similarly.

Retest Policy

There are a number of ways to deal with the issue of retesting vehicles that have failed to meet established emission standards. Having the failed vehicles return to the test facility within a specified time after failing is common to most programs currently in operation. Vehicles failing the inspection are generally required to have appropriate maintenance performed and then return to the inspection station for a retest. The time limit between the initial inspection and retest ranges from 15 to 30 days depending on the state.

Another important issue is whether or not retests will be paid or free to the motorist. To insure consumer acceptance the typical approach is to provide retests within a specified time period at no additional charge. This creates an incentive to bring failed vehicles into compliance promptly, as well as reducing the economic impact of failing the test.

The regulations relating to the time period a failed vehicle is allowed before it must be retested need not be stated in the enabling legislation of an emissions inspection program. It may be appropriate to leave this matter to the discretion of the director of the agency charged with administering the program.

Arizona has included a phrase in House Bill 2313-F that deals with failed vehicles. It reads, "36-1773 D. Any person whose vehicle has been inspected at an official inspection station shall, if such vehicle was not found to comply with the minimum standards, have his vehicle repaired and have the right within thirty consecutive calendar days, but not thereafter, to return such vehicle for one reinspection without charge." Rhode Island legislation reads similarly; "Any person whose vehicle has been inspected at an official inspection station, shall, if such vehicle was not found to comply with the minimum standards, have his vehicle repaired and have the right within twenty (20) consecutive calendar days, but not thereafter, to return such vehicle for one (1) reinspection without charge."

Repair Cost Limits

Any program that requires individuals to make purchases must be both equitable and practical if it is to be successful. The mandatory repairs required by an I/M program to bring all vehicles within established guidelines for allowable emissions must have limits placed on the magnitude of the cost of required repairs. This ceiling will help prevent the program from becoming an excessive burden on the public. Also, for certain vehicles the cost of complying may be so great as to render their operation prohibitively expensive. To ameliorate these problems, repair cost ceilings are usually specified.

These limits may take either/or a combination of two forms. First, an absolute dollar limit on the expense of mandated repairs may be set. If a vehicle owner can show that repairs have been performed up to that limit, the vehicle registration is allowed, regardless of whether or not the vehicle emission level is within standards or not. A second type of limit is defined as a function of the value of the vehicle. Minnesota has adopted such a provision in subdivision 5 of its statute. "Maximum Repair Cost. 1(a) The maximum repair cost for meeting emission standards not covered by any warranty, shall be as follows: a motor vehicle having a value of $2,000 or less, $50, for each full $500 of vehicle value over $2,000, an additional $10. Motor vehicle values shall be determined as provided in Minnesota Statutes, Section 168.013." When absolute dollar limits are used, they are usually set at $50 or $75 with provisions to increase it over time.

Fleet Inspections

Several states have established procedures for certifying owners of fleets of vehicles to self-inspect their vehicles. Commonly included are private or government organizations (other than the Federal Government) that owns or operates a number of vehicles where it is deemed that self-inspection would be more cost effective than requiring that each vehicle travel to the state or contractor inspection stations. Most states have certified fleet inspection stations and have set the number of vehicles needed to qualify for being classified as a fleet at about 15 to 25 vehicles. Fleets include state, city or local government agency vehicles, taxi fleets, rental vehicles, etc.

The benefits of having certified fleet inspection stations include both cost savings to the fleet owners and a potential reduction in the number of centralized inspection stations.

It is important that the state establish adequate supervision and quality assurance controls on the fleet inspection stations. The enabling legislation must stipulate the requirements for certification for fleet stations, surveillance procedures, equipment calibration requirements, and procedures and reasons for revocation of permits.

Section 36-1776 of the Arizona Revised Statutes, entitled "Fleet emissions inspection stations; certificates of inspection; dealer's inventory, investigations; revocation of permit" deals with several issues relating to fleet inspections. It establishes that a registered owner or lessee of a fleet of at least 25 vehicles is eligible to apply to the Director of the Department of Health Services (the I/M program's administrative agency in Arizona) for a permit to establish a fleet emissions inspection station. There are several requirements that must be met before the director can issue a permit. They are:

> "that the applicant:
> 1. Maintains an established place of business for the repair and maintenance of applicant's fleet of vehicles.
> 2. Has obtained approved machinery, tools and equipment to adequately conduct the required emissions inspections, except that notwithstanding any other provisions of this article, or rules or regulations promulgated hereunder, fleet emission inspection stations shall be permitted to inspect vehicles owned or leased by the fleet emission inspection stations, by using either an idle test condition or a loaded test condition.

3. Employs properly trained and licensed personnel with which to perform the necessary labor.
4. Agrees to provide data as may be prescribed by the director."

The statute stipulates that only vehicles found to comply with applicable regulations, "that is meet tailpipe emission level standards," may have certificates of compliance issued to them. The fleet emissions inspection station permit holder is not allowed to inspect or certify any vehicle not owned or leased by the holder. An important phrase which establishes dealer inventory as part of a dealer's fleet, and hence eligible for fleet inspections by the dealer reads, "Vehicles owned by a licensed vehicle dealer and which are held for resale as a part of the dealer's business inventory shall be deemed a part of such dealer's vehicle fleet for purposes of this section."

Part F of Section 36-1776 provides the Director of the Department of Health Services with the authority to investigate fleet inspection stations to verify their compliance with these regulations,

"The director shall investigate the operation of each fleet emissions inspection station as the conditions and circumstances of such operation may indicate. He may require the holder of any fleet permit to submit such documentation required concerning the operation of such inspection station. The director may revoke and require the surrender and forfeiture of any fleet emissions inspection station permit and certificates of inspection of such permittee if he finds that such station is not operated in accordance with this article and the lawful rules and regulations adopted by the director or the holder of such permit has failed or refused to submit records or documentation required."

Minnesota has also addressed the issue of fleet inspection stations. Owners of fleets of 15 or more motor vehicles may apply for fleet inspection station licenses. The applicant must show that "he has facilities, equipment, and personnel to competently perform the inspection." Minnesota also treats motor vehicle inventories held by dealers as part of the dealer's fleet. "All motor vehicles held for resale shall be considered as 'owned' until such time as the motor vehicle is titled in a purchaser's name or otherwise disposed of." The legislation stipulates how many fleet vehicles the pollution control agency may inspect to verify the action taken by a fleet inspection station. "The agency may require owners of fleets of motor vehicles to submit motor vehicles designated by the agency numbering five percent or two motor vehicles, whichever is larger, to inspection annually at official inspection stations, to insure compliance with the provisions of this section."

Minnesota also spells out policy on hearings when a licensee has his license revoked or suspended and when an application for a license is refused. "The agency may revoke or suspend any fleet inspection station license upon a finding that any motor vehicle was wrongly certified as in compliance and may refuse, suspend, or revoke the license upon a finding the licensee does not have the equipment, facilities, or personnel to competently perform inspections as required by this act, or for other just cause. In the event of any refusal, suspension, or revocation of a fleet inspection station license, the licensee or applicant may request, within 30 days of the agency's action, pursuant to Minnesota Statutes, Chapter 15. If a hearing is requested no suspension or revocation shall be effective until after the decision based upon the hearing."

Tampering

Both the Wisconsin Departments of Transportation and Natural Resources have provisions to check whether or not vehicle emission control equipment has been tampered with. In addition to establishing these procedures, penalties have been defined for persons found guilty of tampering with (disconnecting) air pollution control devices and systems.

Removing or disconnecting any ". . . vehicle emission control devices originally installed by the manufacturer or comparable tested placement devices. . ." on any vehicle operated on Wisconsin highways is unlawful according to Subchapter IV, Exhaust and Fuel Systems, of the Department of Transportation, Standards for Motor Vehicle Equipment. Furthermore, MVD 5, Subchapter IX, Homemade or Reconstructed Motor Vehicles, states that it is unlawful for ". . . any vehicle. . .homemade or reconstructed using a 1968 model year engine or later. . ." to be operated on a highway if it does not have proper emission control devices."

The New Dealer's Unit of the DOT's Division of Enforcement has been empowered to enforce these provisions and execute punishment as prescribed in Section 110.075 (7) of the Wisconsin Statutes. In supervising all of the new and used motor vehicle sales operations in the State, the Unit may refuse or deny any dealers found in violation of the regulations the right to do business. The Wisconsin Department of Natural Resources may levy fines of from $10 to $5,000 upon persons violating Section 144.42 Motor Vehicle Pollution, Excerpts of Chapter 83, Laws of 1967. Authority provided through this regulation reads as follows:

> "(2) Except as permitted or authorized by law, no person shall fail to maintain in good working order or remove, dismantle or otherwise cause to be inoperative any equipment or feature constituting an operational element of the air pollution control system or mechanism of a motor vehicle and required by rules of the department to be maintained in or on the vehicle. Any such failure to maintain in good working order or removal, dismantling or causing of inoperability shall subject the owner or operator to suspension or cancellation of the registration for the vehicle. The vehicle shall not thereafter be eligible for registration until all parts and equipment constituting operational elements of the motor vehicle have been restored, replaced or repaired and are in good working order."

Documentation of Repairs Performed

It is necessary to collect data on repairs required by an I/M program in order to evaluate its impact and assure that vehicles returning for reinspection have actually undergone the necessary repairs. If exemptions are granted to vehicles that fail reinspection after having repairs performed, it is essential that some form of documentation be prepared by those actually performing repairs. This type of data would also be necessary to provide the basis for evaluating the efficiency of individual repair shops in performing maintenance and thus would play an integral role in both consumer protection and quality control programs. Further, these data would be useful as input for an overall program evaluation effort, which should be undertaken periodically.

Fees

Enabling legislation generally sets a maximum fee that may be charged for performing a motor vehicle inspection. How many reinspections, if any, covered by the fee collected should also be stipulated? In the event that vehicles are required to undergo reinspections that are not included in the basic fee, the ceiling costs performing the additional inspections should be stated, also.

Minnesota deals with this issue in the following manner. " Fee for Inspection. (a) An inspection fee of not to exceed $10 shall be paid at the official inspection station at the time any motor vehicle is inspected. The inspection fee shall entitle the owner of the motor vehicle to one initial inspection and, if necessary, one full or partial reinspection, at the official inspection station. If two or more reinspections are required, an additional fee of not more than $7.50 per full or partial reinspection shall be set by the agency and charged in the same manner at the time of reinspection. The fee shall cover the contract cost of the inspection and the administration costs of the agency and department under this act. The fee for motor vehicles inspected in a fleet inspection station shall be set by the agency to equal the costs of agency and department fleet license and program administration only. The inspection fee shall also apply to vehicles exempt from license fees pursuant to Minnesota Statutes, Section 68.012."

The last two sentences are particularly important. The first insures that the I/M program will be self-supporting. The fee charged per inspection must be set high enough to cover costs that are incurred in performing the inspection. This is a desirable feature and appears in virtually all I/M enabling legislation.

The last sentence allows a fee to be charged for all vehicles exempt from license fees. These vehicles are usually owned by units of government that are "higher up" than the governmental unit levying the fee. In this case, it is concerned with federally-owned vehicles.

Legislation for other programs cover similar issues, but may be worked differently. Arizona, for example, specifies that fees will be collected along with each vehicle's annual registration charge. This approach provides a positive method of collecting fees that is low in cost. Section 36-1773 of the Arizona Revised Statutes reads as follows:

> "Emission inspection fees; composition and disposition
>
> A. The director shall fix, regulate and alter in accordance with this section, the fees, not to exceed five dollars per inspection, required to be paid for the inspection of every vehicle inspected pursuant to this article.
>
> B. The director shall fix the fees, not to exceed five dollars per inspection. Such fees shall be originally fixed and thereafter adjusted by the director to reflect the contractual charge payable to any independent contractor as well as increase or decrease in costs to the state of providing and administering emissions inspection services.
>
> C. The fees charged for official emissions inspection shall be uniform as applied to each class of vehicle which shall be defined by the director. Except for fees collected by the director pursuant to Section 36-1776, the inspection fee shall be collected with the registration fee by the county assessor at the time and place of motor vehicle registration pursuant to title 28, chapter 3, section 1, and:
>
> 1. The assessor of each county is constituted an agent of the department of transportation for the collection of the emissions inspection fee.
> 2. All monies received from inspection fees by the county assessor shall be immediately transferred by the collecting officer to the state treasurer and by him to the emissions inspection fund.
>
> D. Any person whose vehicle has been inspected at an official emissions inspection station shall, if such vehicle was not found to comply with the minimum standards, have his vehicle repaired and have the right within thirty consecutive calendar days but not thereafter to return such vehicle for one reinspection without charge."

Section 9889.61, Part B of Chapter 1154 of the California Vehicle Code states, "The department shall charge a fee for the inspection of motor vehicles conducted pursuant to Section 9889.55. The revenues from such fees shall be sufficient to provide the State funds to match any federal grants awarded in response to application under subdivision (a), and to reimburse the Motor Vehicle Account in the Transportation Tax Fund for all appropriations made for the design, adoption, implementation, and operation of the inspection program established by this chapter."

Chapter 38 of the general laws of Rhode Island, entitled "Inspection of Motor Vehicles" deals with fees in the following way:

> "31-38.3 Inspection fees; composition and disposition.
>
> a. The registrar (of Motor Vehicles) shall fix, regulate and alter in accordance with this section, the fees required to be paid for the inspection of every vehicle inspected pursuant to this chapter. Such fees shall be originally fixed and thereafter adjusted by the registrar to reflect the contractual charge payable to any independent contractor as well as any

increase or decrease in the costs to the state of providing and administering inspection services.

b. The fees charged for official inspection shall be uniform throughout the State and shall be collected at the point of inspection.

c. Any person whose vehicle has been inspected at an official inspection station, shall, if such vehicle was not found to comply with the minimum standards, have his vehicle repaired and have the right within twenty (20) consecutive calendar days, but not thereafter, to return such vehicle for one (1) reinspection without charge."

Program Commencement and Phase-in Dates

The I/M program commencement date must be stated in the enabling legislation. Several states have implemented programs in phases, often beginning with mandatory inspection but voluntary maintenance. The mandatory maintenance usually begins after 1 year. This approach has been very beneficial since it gives the public time to become acquainted with the basic I/M concepts. Also, it has other important benefits such as allowing time for the repair industry to gain the necessary training and experience in emission related repairs.

Arizona's I/M program began with a 1-year voluntary maintenance period. The sections of Arizona regulations dealing with this issue are R9-3-1004 Parts A and B and they read as follows: "A. Pursuant to ARS §36-1772, all vehicles required by this article to be subjected to the mandatory vehicular emissions inspection shall be required to be inspected, but, from 12:01 a.m. on January 1, 1976 to 12:01 a.m. on January 1, 1977, shall not be required to pass inspection. B. All vehicles required by this article to be subjected to the mandatory vehicular emissions inspection shall be required to pass the inspections subsequent to 12:01 a.m. on January 1, 1977." Section 36-1772 of the Arizona Revised Statutes is referred to by this passage. Section 36-1772 establishes I/M in Arizona. Regarding program commencement it states in Part A of this section that "such inspection shall commence in counties with a population in excess of three hundred fifty thousand by January 1, 1976."

Thus, it is appropriate to establish the date on which an I/M program is initiated in the enabling legislation and determine how to phase it in, should a gradual implementation approach be chosen, via adoption of rules and regulations by the director of the program's administering agency.

Funding

Many states' enabling legislation establish the funding mechanism required for the program. Often this section is included with the fee section, although it may be separate. The funds section first establishes the fund, defines the revenue sources for it, establishes authorized expenditures from it, defines exemptions, and may establish any investment policies. The major revenue sources for the inspection fund generally would be general state appropriations, grants (especially Federal grants), fees from the inspections, and bonds if established for the program. The Arizona legislation established an inspection fund in House Bill 2319 which reads as follows:

> "36-1774. Emissions inspection fund, composition; authorized expenditures; exemptions; investment
> A. There is established an emissions inspection fund which shall consist of:
> 1. Money appropriated thereto by the legislature.
> 2. All money remitted by owners of vehicles which is collected for emissions inspection.
> 3. All money collected by the Director for the issuance of inspection certificates to owners of fleet emissions inspection stations.
> 4. Money received from private grants or donations when so designated by the grantor or donor.
> 5. Money received from the United States by grant or otherwise to assist the State in any emissions inspection program.
> B. The Director of Administration shall approve properly certified claims submitted by the Department of Administration for enforcement of the provisions of this article. When such claims for reimbursement are approved by the Director and transmitted to the State Treasurer, he shall transfer the amounts claimed to the Director of the Department of Health Services.
> C. No monies in the emissions inspection fund shall revert to the general fund or the Department of Health Services and such monies shall be exempt from the provision of Section 35-190, relating to lapsing of appropriations until January 1, 1981.
> Providing and administering emissions inspection services.
> C. The fees charged for official emissions inspection shall be uniform as applied to each class of vehicle which shall be defined by the Director. Except for fees collected by the Director pursuant to Section 36-1776, the inspection fee shall be collected with the registration fee by the County Assessor at the time and place of motor vehicle registration pursuant to Title 28, Chapter 3, Article 1 and:
> 1. The Assessor of each county is constituted an agent of the Department of Transportation for the collection of the emissions inspection fee.
> 2. All monies received from inspection fees by the County Assessor shall be immediately transferred by the collecting officer to the Director of the Department of Transportation and by him to the emissions inspection fund.
> D. Any person whose vehicle has been inspected at an official emissions inspection station shall, if such vehicle was not found to comply with the minimum standards, have his vehicle repaired and have the right within thirty consecutive calendar days but not thereafter to return such vehicle for one reinspection without charge.
> E. The Director shall fix an emissions inspection fee before inspection certificates may be issued to the owner of any fleet emissions inspection station. Such fee shall be uniform for each inspection certificate issued and shall be based upon the Director's

estimated costs to the State of administering and enforcing the provisions of this article as they apply to fleet emissions inspection stations and the vehicles inspected therein. The Director shall promptly transmit all such monies collected by him pursuant to this article to the State Treasurer who shall deposit them in the emissions inspection fund."

Length of Program - Termination or Extension of Contract

The overall duration of an I/M program itself does not have to be specified in the enabling legislation. However, in a contractor approach, the exact time that the contract runs as well as contract termination procedures and provisions are often included. A closely related issue is the fee paid to the contractor. To keep the fee constant over the contract period, the effect of inflation must be taken into account. Correcting for inflation, the fee paid will be in excess of a contractor's costs at the start of a program and below the contractor's costs at the end. The contract duration should reflect the time period used to calculate the constant fee. This prevents contractors from making excess profits now, and assures that the contractor will still be performing inspections when costs exceed fees later on.

Based on other states' programs, an optimum contract period appears to be 5 years. Longer periods bring with them uncertainties about costs and political factors. In addition, it would be important that the state be able to terminate the contract as appropriate at the end of the 5 years (or sooner if need be) with the option of taking over the program, renegotiating with the same operator or contracting with another operator. Contracts of less than 5 years would be financially unattractive to potential contractors unless the initial investments and startup costs were shared between the contractor and the State, or similar arrangements made that would absolve the contractor from making very high initial investments.

Arizona established a 5-year contract in House Bill 2319, Section 36-1775, Part D 1: "A contract term or duration of five years with equitable compensation to the contractor if the provisions of this article are repealed."

Minnesota established a 5-year minimum contract length: "Sec. 4 .... Any contract authorized by this section shall contain, in addition to other provisions, a contract duration for actual operation of the inspection stations of a minimum of five years, and provision for equitable compensation to the contractor, if the provisions of this act are repealed prior to the expiration of the contract term."

Data Collection and Studies

Since Ohio has selected a contractor-run I/M system, it will be necessary to establish in the enabling legislation the authority (requirements, actually) to collect data and conduct studies of individual inspection station performance, repair costs, and overall program effectiveness. Generally in a contractor system, the contractor collects the data, which is subsequently analyzed by the appropriate state agency.

In this approach, the director of the administrative agency is empowered by the enabling legislation to collect and maintain data files.

California has stipulated in Section 8, Section 9889.58 of the Business and Professions Code that information maintained in the records of all facilities performing inspections shall include all of the following:

> "(a) the number of maintenance and repair operations performed on motor vehicles which failed to pass an inspection conducted by the department pursuant to the provisions of this chapter.
> (b) the correlation between maintenance and repairs recommended by the department pursuant to subdivision (b) of Section 9889.51 and maintenance and repairs performed.
> (c) the percentage of maintained and repaired vehicles which passed reinspection.
> (d) the charges assessed for such maintenance and repairs.
> (e) any other information deemed essential by the department."

When an RFP (Request for Proposal) is promulgated and rules and regulations are established, a more complete and refined list of data requirements should be set forth. It should include, but not be limited to, the following:

- vehicle identification number
- test results
- vehicle age
- repairs needed for failed vehicles
- cost of repairs performed on failed vehicles (labor/parts)
- analyzer calibration records (frequency, accuracy, etc.)
- vehicle license number
- owner's name
- number of cylinders*
- vehicle weight class*
- air injection code*

An important element of data collection relates to the need for studies of program effectiveness and periodic revision of certain program elements. Such studies would be particularly important during the early planning stages and, if a contractor were selected towards the end of the contract period.

The Minnesota statute makes the following provisions for data collection and studies:

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*to allow for make/model specific cut-points

> "Subd. 2. (STUDIES, DATA COLLECTIONS, ANNUAL REPORT.)
> The commissioner and the agency shall collect data and undertake studies as are necessary to evaluate the cost, effectiveness, and benefits of the motor vehicle inspection program. The director, the commissioner, the commissioner of transportation and the director of the energy agency or their designees, shall jointly constitute an advisory committee to consider among other issues related to motor vehicle inspection the following:
> (a) the cost, effectiveness, and benefits of the inspection program;
> (b) whether vehicles weighing over 8,500 pounds should be included in the inspection program;
> (c) whether mandatory inspection of motor vehicles should be extended to other areas of the state;
> (d) the desirability of certification, licensing, or bonding of repair facilities for the protection of the public; and
> (e) the desirability of allowing official inspection facility personnel to make minor adjustments with the consent of the motor vehicle owner.
> The director of the agency, or his designee, shall be the chairman of the committee. The director and the committee shall seek information from the general public, consumer groups, environmental groups, and the repair and parts industry regarding these matters, and may establish an advisory committee on motor vehicle inspection if it deems advisable. The agency shall report on these matters and the general operation of the motor vehicle inspection program to the legislature on or before January 1, 1982 and each four years thereafter."

Mechanic Training

Some states specifically have provisions in the I/M enabling legislation that mechanic training courses be conducted. Generally, the important aspects of this section are to establish the requirement for such training and define which agency is to be responsible for setting up and administering the program. It is also possible that the designated agency would hire a contractor solely for the purposes of designing and operating a mechanic training program. In the Minnesota legislation the following wording is used:

> "Sec. 8....(b) The agency, in cooperation with the commissioner, shall provide information on motor vehicle repairs and conduct vehicle repair seminars and training programs for the public and repair industry."

Public Information Program

Some mention of the type of public information program and the approximate scope it should encompass should be made. Enabling legislation should specify who is empowered to establish this effort. The methods of information promulgation (mass media, direct mailings, etc.) may be specified. Alternately, it may be sufficient to state that each motor vehicle owner affected by an

I/M program should be made aware of certain aspects of the program; i.e., program goals, program requirements, location and hours of inspection facilities, etc. In establishing a contractor-run network with computer capabilities, Ohio can require that the contractor provide consumer protection information along with a fail report to all owners of vehicles that do not meet standards. This information may include, but not necessarily be limited to, a list of probable conditions that are causing the vehicle to be out of compliance and a list of recommended repair centers.

It is important to specify when the public information effort will commence and the level of effort over time. The actual dissemination of information should begin sometime prior to the program's starting date. Usually this occurs between 6 months and 1 year prior to the first inspection.

The actual wording of the section of the enabling legislation dealing with this issue will depend on how the phasein sequence is handled.

Minnesota dealt with this matter in the following manner:

> "Sec. 8. (Public Information, Training.)
> (a) The agency, in cooperation with the commissioner, and in conjunction with the official inspection station contractor, shall design, prepare, and implement a public education and information program for the motor vehicle inspection program, including, but not limited to, materials for distribution, presentations, mass media releases, and other appropriate public educational items. The public education program shall commence a minimum of six months before mandatory motor vehicle inspection is required.
> (b) The agency, in cooperation with the commissioner, shall provide information on motor vehicle repairs and conduct vehicle repair seminars and training programs for the public and repair industry."

SECTION 8

COST ANALYSIS

METHODOLOGY

The development of the specific costs presented in this section relies on an analysis and breakdown of the program elements into specific cost components. These cost components are based on the actual experiences of other states which have implemented I/M programs very similar to the contractor-operated centralized network described in this report. Arizona has an I/M program similar in many ways to the one analyzed here. In addition, a thorough analysis of the program functions and elements was undertaken to make sure that the costs reflect as closely as possible the probable costs that will be experienced when Ohio implements the proposed I/M program. However, it must be realized that while conservative cost assumptions were made whenever feasible, that there is considerable variation in the individual cost elements due to fluctuations in markets and in the economy. Salaries may vary not only due to inflation but the state salaries will vary in a less predictable fashion because the legislature is responsible for each raise in overall salary schedules. The costs have been estimated as closely as possible and compared to existing programs.

All costs specified in this section are reported in constant 1978 dollars (i.e., inflation is assumed to be nonexistent). Methodologies used in developing costs for the specific elements outlined in Table 24 are described below.

Initial Capital Costs

These costs reflect the initial expenditures required for obtaining and improving land, constructing the test facilities, purchasing and installing primary test equipment, ancillary equipment, office equipment, and maintenance equipment. These items are categorized into three primary elements: building investments, land investments, and equipment costs.

Building Investments--

Building costs are obviously dependent on specific designs, features utilized, and construction materials used; therefore, the unit costs (on a dollar basis) can be expected to vary considerably. For the centralized facilities being considered here, a general design description was developed and submitted to the Ohio Department of Transportation for an assessment of

TABLE 24. OUTLINE OF PROGRAM COST CATEGORIES AND ELEMENTS

Primary category	Principal element	Items included
I. Initial Capital Costs	1. Building investment	a. Construction cost
	2. Land investment	a. Actual land cost b. Pavement and landscaping
	3. Equipment costs	a. Primary test equipment b. Ancillary equipment c. Office equipment/furniture d. Maintenance equipment
II. One-Time Startup Costs	1. Land acquisition	a. Site location studies b. Title transfer costs
	2. Facilities planning	a. Design study b. Bid evaluation c. Construction monitoring
	3. Program design	a. Develop equipment specifications b. Develop subprograms (e.g., public information, surveillance, quality control, enforcement, etc.) c. Define personnel organizational structure d. Define personnel organizational structure e. Plan program effectiveness studies
	4. Develop data handling systems software	
	5. Personnel training	a. Inspectors b. Managers c. Quality control personnel d. Mechanics training
	6. Personnel salaries and overhead prior to startup	
	7. Initial public information program	
	8. Mechanics training program	
III. Annual Operating Costs	1. Facility personnel	a. Wages, benefits, etc.
	2. Maintenance	a. Equipment
	3. Utilities/services/supplies	a. Electric b. Heat c. Insurance d. Miscellaneous e. Taxes
IV. Annual Administrative Costs	1. Program administrative personnel	a. Wages, overhead
	2. Enforcement	
	3. Consumer protection quality assurance	
	4. Public information	
	5. Training, licensing, certification	

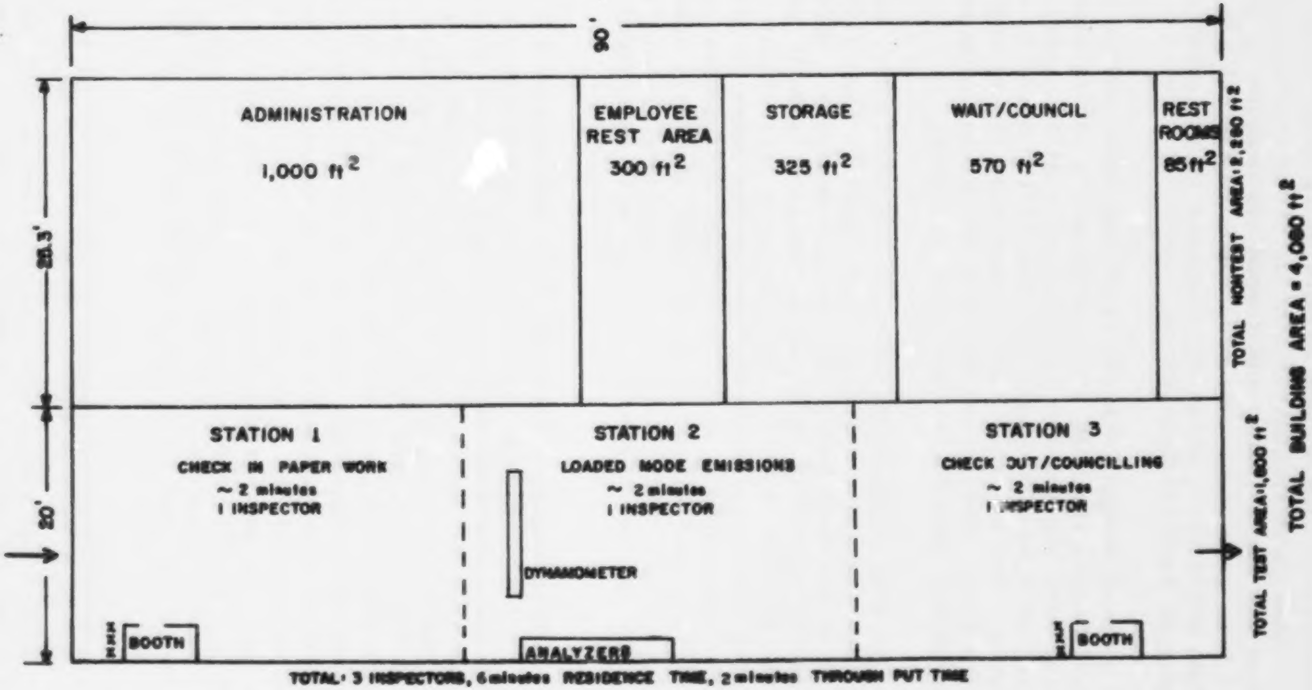
the likely cost. The general building design calls for a clear span, metal structure, utilizing metal sandwich panel walls with normal wall and ceiling finish in the administrative areas, and no wall or ceiling finish in the inspection areas. Items such as central heating and air-conditioning in the administrative areas and air exchange and forced air heaters in the inspection area were included. No provisions were made for more specialized systems such as exhaust fume collectors; these are included in equipment costs under the general category of facility furnishings.

Based on the general design features described above and on the general building size requirements, the Ohio State Architect's Office examined the most recent building cost figures for buildings of similar construction. These figures, based on five ODOT projects (from 1971 and 1972), were updated to reflect 1978 costs. For mid 1978, the average cost figure was estimated at $27.75 per square foot. This value was used in the building cost evaluations for all centralized lane facilities configurations.

It is noted here that discussions with one I/M contractor, Hamilton Test Systems, indicate that the basic building costs could be significantly more than the $27.75 per square foot being used in this analysis. Apparently, the general building design typically utilized by Hamilton is much more substantial than that proposed here, and the cost increases accordingly. In fact, it has been indicated that a construction cost in the range of $35 to $40 per square foot would be reasonable. In spite of these differences in cost estimated, the unit cost provided by the State was used primarily because it is likely that the State would actually define the building specifications with regard to general type and it is assumed that the most economical design would be selected.

An analysis of the specific inspection tasks and equipment to be used was made to define the general features required of an I/M inspection facility. Literature searches and interviews with individuals involved in operating similar programs resulted in the establishment of two separate specific building requirements. The first type, urban facilities, are intended for counties whose motor vehicle populations are sufficiently large to require a 2-minute rate to achieve cost-effectiveness. The second type, rural facilities, are intended for counties with relatively small motor vehicle populations, enabling construction of a smaller facility at the expense of the throughput rate, which is not so critical in these counties. Conceptual floor plans for both an urban facility and a rural facility, are provided in Figures 10 and 11, respectively. The floor plans show one-lane facilities; building areas required for facility configurations ranging from one to six lanes for urban facilities and one to two lanes for rural facilities are presented in Table 25.

The cost for each facility is computed as the product of (1) the building area, and (2) the unit cost, $27.75 per square foot. The total cost for the network is the sum of the individual stations, derived in Section 4. This network is summarized by facility configuration in Table 26. The total cost for the construction of facilities, presented in Table 27, was found to be $22,960,915.



90'
25.3'
20'
ADMINISTRATION
1,000 ft^2
EMPLOYEE REST AREA
300 ft^2
STORAGE
325 ft^2
WAIT/COUNCIL
570 ft^2
REST ROOMS
85 ft^2
TOTAL NONTEST AREA: 2,280 ft^2
STATION 1
CHECK IN PAPER WORK
~ 2 minutes
1 INSPECTOR
STATION 2
LOADED MODE EMISSIONS
~ 2 minutes
1 INSPECTOR
STATION 3
CHECK OUT/COUNCILLING
~ 2 minutes
1 INSPECTOR
DYNAMOMETER
BOOTH
ANALYZERS
BOOTH
TOTAL TEST AREA: 1,800 ft^2
TOTAL BUILDING AREA = 4,080 ft^2
TOTAL: 3 INSPECTORS, 6 minutes RESIDENCE TIME, 2 minutes THROUGH PUT TIME

Figure 10. Conceptual floor plan for an urban loaded mode inspection facility.

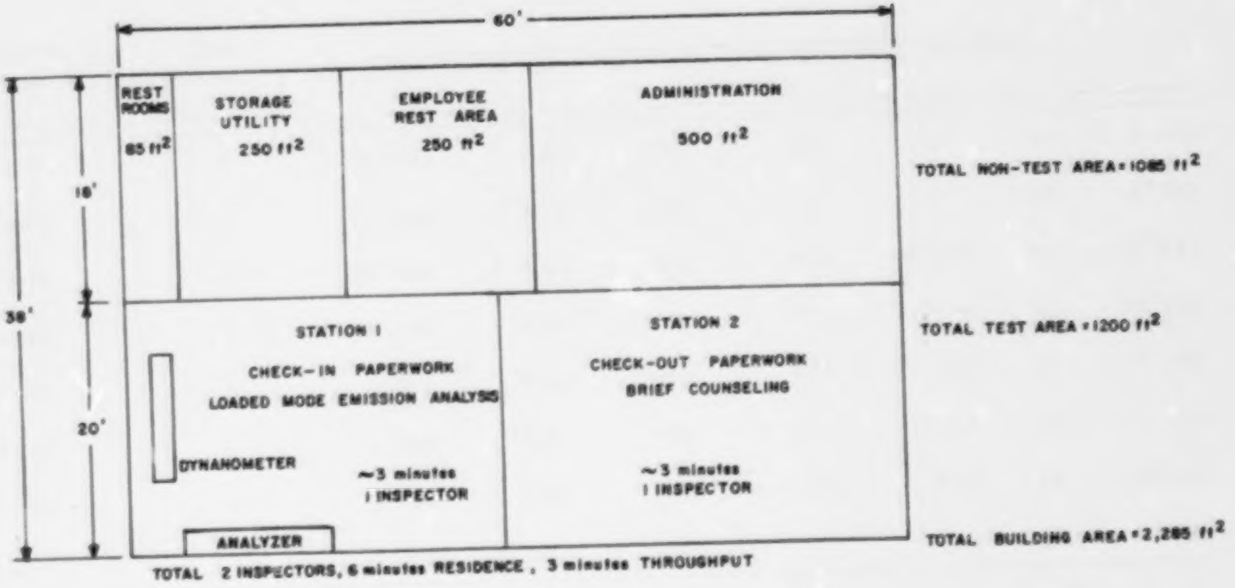

60'
38'
18'
20'
REST ROOMS
65 ft²
STORAGE UTILITY
250 ft²
EMPLOYEE REST AREA
250 ft²
ADMINISTRATION
500 ft²
TOTAL NON-TEST AREA = 1065 ft²
STATION 1
CHECK-IN PAPERWORK
LOADED MODE EMISSION ANALYSIS
DYNAMOMETER
~3 minutes
1 INSPECTOR
ANALYZER
STATION 2
CHECK-OUT PAPERWORK
BRIEF COUNSELING
~3 minutes
1 INSPECTOR
TOTAL TEST AREA = 1200 ft²
TOTAL BUILDING AREA = 2,265 ft²
TOTAL 2 INSPECTORS, 6 minutes RESIDENCE, 3 minutes THROUGHPUT

Figure 11. Conceptual floor plan for a rural loaded mode emissions inspection facility.

TABLE 25. BUILDING FLOOR AREAS FOR VARIOUS FACILITY CONFIGURATIONS

Facility type	Configuration (lane)	Floor area required (ft^2)*						
		Test area	Administration	Employee rest	Storage	Waiting	Restrooms	Total
Urban	1	1,800	1,000	300	325	570	85	4,080
Urban	2	3,600	1,000	350	350	930	85	6,315
Urban	3	5,400	1,000	400	380	1,530	85	8,795
Urban	4	7,200	1,000	440	410	2,370	85	11,505
Urban	5	9,000	1,000	485	435	3,450	85	14,555
Urban	6	10,800	1,000	525	465	4,770	85	17,645
Rural	1	1,200	500	250	250	0	85	2,285
Rural	2	2,400	500	250	250	0	85	3,485

*Source: Callender, J. H., Time Saver Standards for Architectural Design. McGraw Hill. 1974.

TABLE 26. NETWORK REQUIREMENTS BY FACILITY CONFIGURATION

Facility type	Configuration (lanes)	Number of facilities	Total lanes
Urban	2	14	28
Urban	3	15	45
Urban	4	3	12
Urban	5	2	10
Urban	6	24	144
Rural	1	16	16
Rural	2	29	58
Total		103	313

TABLE 27. BUILDING COST ESTIMATES

Facility type	Facility configuration	Per facility cost ($)	Number of facilities required	Total cost ($)
Urban	2	175,241	14	2,453,374
Urban	3	244,061	15	3,660,915
Urban	4	319,264	3	957,792
Urban	5	403,901	2	807,802
Urban	6	489,649	24	11,751,576
Rural	1	63,409	16	1,014,544
Rural	2	96,709	29	2,804,561
Total			103	23,450,564

Land Investments--

A number of issues beyond the obvious one of land area are extremely crucial in estimating land costs. The basic unit cost, for example, is, in most instances, lot-specific to the extent that the per square foot cost may easily vary by a factor of three within any block; within any municipality, the unit cost may vary by a factor of 10 or more. Available lots may also be limited with respect to size requirements, necessitating the purchase of lots exceeding the general requirements, or even the purchase of unwanted structures. It is obvious, then, that a precise unit cost for land cannot be provided here. Alternatively, estimates were derived from discussions with various local assessors and cost figures developed by the Ohio Department of Economic and Community Development. A unit cost of $1.00 per square foot was derived, based on the general requirements in terms of lot size, access, zoning, etc., for a typical inspection facility.

Specific lot size requirements are a function of facility configurations. A general relationship exists between land area required and test facility size. Specifically, a ratio of land area to building area can be derived based on queuing and zoning requirements; for Ohio, this ratio is approximately 5:1. Since building area requirements have been derived (see Table 25), land areas may be easily calculated.

Improvements to the land are also included in this category. This involves primarily pavement and landscaping. Various landscape architects have indicated that the unit costs for black-top paving and standard finish landscaping are approximately $0.80 per square foot and $0.25 per square foot, respectively. Total land investments, including improvements are presented in Table 28.

Equipment Costs--

The major equipment items required to operate a loaded-mode emissions test facility were identified based on analyses of inspection task requirements and conversations with individuals currently involved in these types of testing programs.

The equipment cost estimates used in this study were developed primarily from interviews with manufacturer's representatives. These interviews focused on identifying the most appropriate type and model for various major items and determining the general level of skill required to operate and maintain each. Outlined in Table 29 are the equipment requirements and associated costs for a loaded-mode emission inspection program.

Equipment costs for any facility configuration, then, can be derived from Table 29. A summary of equipment costs as a function of the facility configuration is shown in Table 30.

The total network cost for test equipment can be computed based on the number of facilities by configuration, developed previously. These costs, presented in detail in Table 31, total $22,794,500.

TABLE 28. ESTIMATED LAND INVESTMENT REQUIREMENTS BY FACILITY CONFIGURATION

Facility type	Configuration (lanes)	Facilities required	Lot size per facility (ft^2)	Land cost per ft^2 ($)	Raw land cost per facility ($)	Total cost all facilities ($)	Total queue area[a] all facilities (ft^2)	Total parking area[b] all facilities (ft^2)	Total paved area all facilities (ft^2)	Paving cost per ft^2 ($)	Total paving cost ($)	Total landscaped area, all facilities (ft^2)	Landscaping cost per ft^2 ($)	Total landscaping cost ($)	Total improvements all facilities ($)	Total land investment all facilities ($)
Urban	2	14	31,575	1.00	31,575	442,050	140,000	45,360	185,360	0.80	148,288	168,280	0.25	42,070	190,358	632,408
Urban	3	15	43,975	1.00	43,975	659,625	225,000	72,900	297,900	0.80	288,320	229,800	0.25	57,450	345,770	1,005,395
Urban	4	3	57,525	1.00	57,525	172,575	60,000	19,440	79,440	0.80	63,552	35,610	0.25	8,903	72,455	245,030
Urban	5	2	72,775	1.00	72,775	145,550	50,000	16,200	66,200	0.80	59,260	50,240	0.25	12,560	71,820	217,370
Urban	6	24	88,225	1.00	88,225	2,117,400	720,000	233,280	953,280	0.80	762,624	740,640	0.25	185,160	947,784	3,065,184
Rural	1	16	11,425	1.00	11,425	182,800	80,000	25,920	105,920	0.80	84,736	40,320	0.25	10,080	94,816	277,616
Rural	2	29	17,425	1.00	17,425	505,325	290,000	93,960	383,960	0.80	307,168	20,300	0.25	5,075	312,243	817,568
Total		103				4,225,325					1,713,948			321,298	2,035,246	6,260,571

[a] 5,000 ft^2 per lane.

[b] 1,620 ft^2 per lane.

TABLE 29. MAJOR EQUIPMENT ITEMS REQUIRED FOR LOADED-MODE EMISSIONS TESTING

Program element	Item	Remarks	Unit cost ($)
I. Emissions	1. Chassis dynamometer	Needed for loaded-mode emission test. One unit per test lane required. Cost based on conversations with manufacturers (Clayton, Maxwell).	14,000
	2. Emission analyzer	Since loaded-mode is used, analyzer should be capable of measuring CO, HC, and NO_x. Extremely wide range in analyzer costs; cheaper analyzers found to be inadequate. Analyzers should be capable of being tied into computer data handling system. Costs based on discussions with manufacturers (Olson-Horiba, Hamilton Test Systems). One unit per test lane required.	26,500
II. Data System	1. CRT Terminals	Two required per lane. Costs based on literature and discussions with manufacturer's representatives (Honeywell, Digital, Olivetti, Sperry Univac), and experiences of other states.	2,500
	2. Minicomputer	One required per facility (equivalent to Digital PDP-11-05). Generally assumed to be included in the cost of facility furnishings.	80,000
III. Miscellaneous	1. Miscellaneous tools	As required.	1,000

TABLE 30. EQUIPMENT COSTS AS A FUNCTION OF FACILITY CONFIGURATION

Number of lanes	Equipment costs ($)
1	126,500
2	173,000
3	219,500
4	266,000
5	312,500
6	359,000

TABLE 31. EQUIPMENT COSTS FOR A LOADED-MODE TESTING NETWORK

Facility type	Configuration (lanes)	Facilities required	Equipment cost per facility ($)	Total cost of equipment ($)
Urban	2	14	173,000	2,422,000
Urban	3	15	219,500	3,292,500
Urban	4	3	266,000	798,000
Urban	5	2	312,500	625,000
Urban	6	24	359,000	8,616,000
Rural	1	16	126,500	2,024,000
Rural	2	29	173,000	5,017,000
Total test equipment				22,794,500
Central Computer				250,000
Security Systems				1,122,000
Calibration Vans				1,023,000
Quality Assurance Vans				330,000
Investigators Cars				60,000
Total				25,579,500

In addition to these equipment costs, five additional items must be included in the total network equipment costs; these include a central computer, security systems, calibration vans, quality assurance vans, and complaints investigator's cars.

One calibration van is required for each maintenance/calibration person. In Section 5, it was determined that 31 maintenance/calibration people would be required. The cost summary for each van is presented below:

1/2 ton light-duty van	$ 5,500
Spare analyzer	26,500
Tools, gases, etc.	1,000
Total cost per van	$33,000

This equates to an expenditure of $1,023,000 for maintenance calibration vans.

As a quality assurance mechanism, the State of Ohio will have five regional calibration investigators to check on the calibration of the contractor's analyzers and to assure proper inspection procedures are being observed. The state will also have five fleet calibration coordinators to check analyzers and service records of fleet owners who perform their own inspections. This equates to a total of 10 additional vans or $330,000.

The state will have 10 regional complaints investigators to handle general complaints concerning both inspections and the repair industry. Each of these investigators will be provided with a car estimated to cost $6,000 each. This translates to a total cost of $60,000.

The entire network would be tied into a central computer equivalent in capability to a digital PDP-11-35. Cost estimates were obtained from several manufacturer's representatives, including Digital, Olivetti, Honeywell, and Sperry Univac, and an average cost of approximately $250,000 was derived.

Each facility should be equipped with security systems to protect against theft and/or vandalism. A contractor has suggested a cost of $1,100 per facility for purchase and installation of security systems. This translates to a total cost of $1,122,000. The total equipment cost estimate, itemized in Table 31, is $25,579,500.

The anticipated capital costs are summarized in Table 32.

One-Time Startup Costs

Implementation of an I/M program will require the expenditure of monies for noncapital items and services on a one-time basis prior to the actual startup. Costs associated with this category are perhaps the most difficult to define at this point primarily because the elements involve services (program planning, design, development, etc.), which are inherently much more variable in cost than, for instance, equipment or building costs. Considerations used in developing cost estimates for each element are discussed with the presentation of the individual estimates as follows.

TABLE 32. INITIAL CAPITAL COST SUMMARY

Category	Item	Item cost ($)	Category cost ($)
Building investment	Construction	23,450,564	
			23,450,564
Land investment	Purchase	4,225,325	
	Paving	1,713,948	
	Landscaping	321,298	
			6,260,571
Equipment Investment	Facility Equipment	22,794,500	
	Central Computer	250,000	
	Security Systems	1,122,000	
	Calibration Vans	1,023,000	
	Quality Assurance Vans	330,000	
	Investigators Cars	60,000	
			25,579,500
Total			55,290,635

Land Acquisition--

Included in this element are the costs for identifying and locating candidate sites, negotiating purchase price, and completing title transfers. Site location and price negotiation would involve approximately 200 man-hours of professional technical time, plus 40 man-hours of professional legal time for each site. To translate man-hours to actual cost figures, a $20 per hour and $50 per hour value were assigned to technical and legal hours, respectively; this represents a total cost of $6,000 per site to cover location and negotiation. Title transfer involves physical surveys, title searches, site plan preparation, and miscellaneous support functions required to execute the purchase. The cost associated with this component is estimated to be approximately 10 percent of the unimproved land value.

For the network described previously, a total of 103 sites are required reflecting a total unimproved land investment of $4,225,325. The cost for land acquisition, then, is calculated below:

(103 facilities)($6,000/facility) + (0.10)($4,225,325)
= ($618,000 + $422,533) = $1,040,533

Facilities Planning--

This element reflects the costs associated with engineering and design for the test facilities, bid review, and construction monitoring. The value of these services is estimated as a function of the building cost; specifically, 15 percent of the building construction expenditure. Since the total building cost is estimated to be $23,450,564, the planning cost can be calculated as:

(0.15)($23,450,584) = $3,517,585

Program Design--

The costs associated with program design reflect additional planning studies required to establish specific formats for the operation and administration of both the actual inspection program and adjunctive programs such as public information, mechanics training, etc. These costs are likely to be quite variable, depending on factors such as the extent of "in-house" effort undertaken by the state. In deriving our estimate, the experiences of other states were weighted most heavily in our analysis of the likely requirements specific to Ohio. Based on the analysis, an estimate of $150,000 was derived as the program cost.

Data Handling Software Development--

A comprehensive data handling software package will be required to provide both basic recordkeeping and program analysis functions. In developing an estimate experiences of other states, conversations with representatives of commercial data processing firms, and an analysis by our own staff were taken into consideration. Based on these discussions and our analysis of the likely requirements specific to Ohio, an estimate of $200,000 was developed for this element.

Personnel Training--

Personnel training will require both an ongoing effort as well as an intensive initial program to essentially train and certify the entire staff of inspectors, managerial, and maintenance/calibration personnel. A similar effort will be required to provide a mechanics training program to adequately prepare the repair industry for the maintenance phase of the program. This will be discussed separately.

To develop cost estimates for training, it was considered that a logical approach would be for the managers and assistant managers to be trained as instructors, allowing a continuation of the training program after initiation of the program without the necessity of a full time instructor. Managers would be able, then, to train any new employees themselves. The managers also would be able to provide training for the inspectors and calibration/maintenance personnel.

Cost estimates for training were developed based on information obtained from the Colorado State University program. The estimated costs for training was found to be $53.00 for each manager and assistant manager, and $16.00 for each inspector and calibration/maintenance person.

From Section 5, the operating personnel requirements for the entire network were:

103 Managers

58 Assistant Managers

865 Inspectors

31 Maintenance/Calibration persons

Applying the training costs derived previously to these personnel requirements, the cost of training operating personnel can be calculated as follows:

(103 managers)($53.00) + (58 assistant managers)($53.00)

+ (865 inspectors)($16.00) + (31 maintenance/calibration persons)($16.00)

= $22,869.00

In addition to operating personnel, the state will be required to train five regional calibration investigators, five fleet calibration coordinators, and 10 regional complaints investigators. A cost of training the investigators was previously developed as $59.00. The cost of training the 20 individuals necessary can be calculated as follows:

(20 investigators/coordinators)($59.00) = $1,180.00

The total cost, then, is the sum of the cost of training operating personnel plus the cost of training investigators, or:

$22,869.00 + $1,180.00 = $24,049.00

Personnel Salaries--

The costs for operating and administrative personnel were derived from data obtained from the Ohio Department of Administrative Services, Division of Personnel, and an overhead estimate of 25 percent was based on data from the U.S. Department of Labor and State.

The literature and interviews with both officials from states with existing I/M programs and private contractors involved in I/M program operation, indicate that the managerial, support, and technical personnel should be phased into the program prior to beginning mandatory inspection. This phase-in would bring managerial personnel in 6 months prior to startup, while inspectors would begin 1 month before the mandatory phase. Support personnel would be phased-in throughout this period. During this period, personnel would become familiar with their specific job functions and general procedures. This phase could include voluntary inspection, which would provide a realistic working environment without the stress of maintaining a rather rigid production schedule as required during the mandatory phase. This phase serves as a "shakedown" period for the equipment and test itinerary, as well.

Given the above defined phase-in and salary schedules, a total personnel cost estimate for startup can be calculated as follows:

[(103 managers)($1,250/month)(6 months)
+ (58 assistant managers)($1,083/month)(6 months)
+ (31 maintenance/calibration officials)($1,000/month)(1 month)
+ (865 inspectors)($750/month)(1 month) 1.25
= $2,286,418.

The administrative personnel costs must also be included in the startup phase. These persons will be phased in 12 months prior to startup. Based on the personnel requirements and salaries derived earlier, the costs associated with startup are presented in Table 33.

The total personnel cost for the start-up period, then, is the total of the operational personnel and administrative personnel costs, or: $2,286,418 + $1,148,750 = $3,435,168.

Initial Public Information Program--

The experience thus far with I/M program operation indicates a definite requirement for an intensive public information effort prior to the actual startup of the program. Based on the experiences of other states, the effort should begin approximately 12 months prior to startup. This time requirement is discussed in greater detail in Section 6. A preimplementation budget of $0.12 per test has been suggested. The average annual number of inspections for the period of 1982 to 1987 has been projected at approximately 9,901,000; this translates to a preimplementation cost of $1,188,120.

Mechanics Training Program--

A complete discussion of the anticipated mechanics training program is presented in Section 6. Based on this discussion, the cost of training mechanics was derived for three levels of participation. For the purpose of this cost estimate, a 50 percent participation rate is assumed. This translates to a total of 4,800 dealers, repair shops, and service stations,

TABLE 33. ADMINISTRATIVE PERSONNEL COSTS ASSOCIATED WITH PROGRAM STARTUP

	Number of positions	Annual salary ($)	Total 12-month salaries for all positions ($)
Administrator, State	1	25,000	25,000
Asst. Administrator for Supporting Services, State	1	20,000	20,000
Asst. Administrator for Field Operations, State	1	20,000	20,000
Legal Counsel, State	1	16,000	16,000
Purchasing Officer, State	1	12,000	12,000
Contracts Officer, State	1	12,000	12,000
Accountant, State	1	12,000	12,000
Engineer, State	1	16,000	16,000
Systems Analyst, State	1	15,000	15,000
Statistician/Programmer, State	1	13,000	13,000
Mechanics Training Program Coordinator, Private Contractor*	1	13,000	13,000
Public Relations Coordinator, State	1	12,000	12,000
Calibration Overseer, State	1	14,500	14,500
Administrator for Station Operations, Contractor	1	25,000	25,000
Inspector Training Coordinator, Contractor	1	13,000	13,000
Legal Counsel, Contractor	1	16,000	16,000
Purchasing Officer, Contractor	1	12,000	12,000
Accountant, Contractor	1	12,000	12,000
Contracts Officer, Contractor	1	12,000	12,000
Engineer, Contractor	1	16,000	16,000
Systems Analyst, Contractor	1	15,000	15,000
Calibration Investigators, State	5	12,000	60,000
Complaints Investigators, State	10	12,000	120,000
Fleet Calibration Coordinators, State	5	12,000	60,000
Labor Relations Officials, Contractor	5	15,000	75,000
Instrument Repair Technicians, Contractor	5	15,000	75,000
Public Relations Officials, Contractor	5	12,000	60,000
Calibration/Maintenance Coordinators, Contractor	5	12,000	60,000
Regional Managers	5	17,500	87,500
Total salaries for 12-month startup period			919,000
25 percent overhead			229,750
			1,148,750

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*This contractor will be separate from the "contractor" noted elsewhere.

and a cost of $105,600 (based on $22 per mechanic and one mechanic per shop). The additional five instructors will need to be trained at an estimated cost of $150 each. The total initial startup cost for the mechanics training program, then, is the total of the cost to train instructors plus the cost to train mechanics:

$$\$750 + \$105,600 = \$106,350$$

A summary of anticipated startup costs is presented in Table 34.

TABLE 34. SUMMARY OF STARTUP COSTS

Item	Cost ($)
Land acquisition	1,040,533
Facilities planning	3,517,585
Program design	150,000
Data handling, software development	200,000
Personnel Training	24,049
Personnel salaries and overhead	3,435,168
Public information	1,188,120
Mechanics training	106,350
Total startup cost	9,661,805

Annual Operating Costs

Annual operating costs include all costs associated with the actual operation of the program. Here, the costs of adjunctive programs (e.g., public information, inspection/mechanic training, etc.) are included under "Annual Administrative Costs," which are discussed later.

Facility Personnel--

Annual determinants of costs associated with the operation of the inspection facilities are: (1) the total number of individuals and relative level of job responsibility, and (2) the per-unit cost of wages and overhead.

In computing personnel costs, the personnel requirements and wage scale derived previously were employed. Applying the facility staffing requirements and annual salaries associated with job category, the annual personnel costs can easily be computed. This estimate is presented in Table 35.

TABLE 35. ANNUAL PERSONNEL COSTS FOR FACILITY PERSONNEL

Job title	Total number of positions	Annual salary ($)	Total annual salaries for all positions ($)
Manager	103	15,000	1,545,000
Assistant Manager	58	13,000	754,000
Calibration/Maintenance	31	12,000	372,000
Inspectors	865	9,000	7,785,000
Total salaries			10,456,000
Overhead at 25 percent			2,614,000
			13,070,000

Maintenance--

Costs associated with equipment maintenance reflect equipment repair and preventive maintenance expenditures. In this connection, the yearly cost of these items was estimated to be 20 percent of the original equipment cost. Specifically, this would be:

(0.20)($22,794,500) = $4,558,900

Utilities/Services/Supplies

Included in this element are the costs associated with electricity, heat, water, building services, insurance, office supplies, uniforms, inspection forms, etc. These costs were estimated based on several sources concerning equipment and facility power requirements determined from manufacturers and the general literature and the prevailing utility rates in the state, average heating requirements data for similar facilities, insurance costs and general building service requirements from existing programs.

Utilities--

Annual cost for utilities were derived from electric usages experienced by other states. For loaded-mode emission testing in the absence of safety, the rates were found to be: 120 kWh/day for each lane, and 325 kWh/day per facility. An average per kilowatt cost of $0.05 kWh was obtained from several Ohio utility companies. The annual cost for utilities, then, is calculated below:

(313 lanes)(120 kWh/day)($0.05/kWh)(250 operating days/yr)
+ (103 facilities)(325 kWh/day)($0.05/kWh)(250 operating days/yr)
= $469,500 + $418,438 = $887,938 annually

Insurance--

It is assumed that the facilities would be covered by liability, fire, theft and vandalism insurance. A contractor from another state has suggested a cost of approximately $1,500/lane. Annual costs based on this estimate are calculated below:

(313 lanes)($1,500/lane) = $469,500 annually

Computer Operation--

Based on discussions with a contractor from another state, and with representatives of several data processing firms, an estimated central computer operation cost for an automated inspection system of $0.15 per test has been derived. This translates to an annual cost of $1,485,150 for central computer operation.

Inspection Forms--

The inspection forms serve the purpose of reporting the test results and authorizing as well as providing the "certificate of compliance" or "certificate of waiver" required for motor vehicle registration. A cost of $0.03 per test has been derived based on the experience of a contractor from another state. This computes to a total test forms cost of $297,030 annually.

Calibration Costs--

The recurring annual cost of equipment calibration, in addition to personnel salaries previously presented, is defined as the cost of calibration gases plus the operating cost of the maintenance/calibration vans. The total annual calibration costs are outlined in Table 36, and were found to be $341,000.

TABLE 36. ANNUAL CALIBRATION COSTS

Item	Cost ($)
Calibration gases (13 sets/year at $200/set)	2,600
Maintenance on van and equipment (20% of purchase price)	6,600
Operating cost ($0.15/mile, 12,000 miles)	1,800
Cost per calibration/maintenance van	11,000
Vans	31
Annually	341,000

Taxes--

The contractor would be required to pay taxes on personel property and real estate. Total annual taxes are itemized by municipality in Appendix D. The "additional equipment" category includes vans and cars and the central computer, all assumed housed in Columbus. Tax rates were obtained from 1976 Actual Tax Rates on Real Property for Current Expenses and Debt in Ohio Cities. Table PR-5 No. 2 (1978). From Appendix D, the total annual taxes amount to $2,351,022.

Uniforms--

Each facility employee is assumed to be furnished a set of uniforms. From discussions with uniform suppliers, an annual cost per employee of $125.00 was derived. This translates to a total annual cost of $132,125 for 1,057 uniformed employees.

The total annual cost for utilities, services, and supplies is provided in Table 37.

TABLE 37. ANNUAL COST FOR UTILITIES, SERVICES, AND SUPPLIES

Item	Annual cost ($)
Utilities	887,938
Insurance	469,500
Computer operation	1,485,150
Inspection forms	297,030
Calibration costs	341,000
Taxes	2,351,022
Uniforms	132,125
Total	5,963,765

Annual Administrative Costs

Costs involved in this category reflect the overall program administrative effort. Specifically, the salaries of personnel involved in areas such as enforcement, consumer protection, public information, training, and certification are included. Also, the operating costs for quality assurance and consumer protection vehicles fall into this category.

Program Administrative Salaries and Overhead--

Annual administrative personnel costs are computed from the personnel requirements and salaries delineated previously. The annual cost computations are presented in Table 38.

Vehicle Operating Costs--

The state will have five regional calibration investigators, five fleet calibration coordinators, and 10 regional complaints investigators; thus a total of 20 vehicles. Assuming the operating cost is $0.15 per mile and annual travel of 12,000 miles each, the annual cost of vehicle operation may be computed:

(20 vehicles)(12,000 miles/vehicle)($0.15/mile) = $36,000

TABLE 38. ANNUAL ADMINISTRATIVE PERSONNEL COSTS

Job title, affiliation	Number of positions	Annual salary ($)	Total annual salaries for all positions ($)
Administrator, State	1	25,000	25,000
Asst. Administrator for Supporting Services, State	1	20,000	20,000
Asst. Administrator for Field Operations, State	1	20,000	20,000
Legal Counsel, State	1	16,000	16,000
Purchasing Officer, State	1	12,000	12,000
Contracts Officer, State	1	12,000	12,000
Accountant, State	1	12,000	12,000
Engineer, State	1	16,000	16,000
Systems Analyst, State	1	15,000	15,000
Statistician/Programmer, State	1	13,000	13,000
Mechanics Training Program Coordinator, Private Contractor*	1	13,000	13,000
Public Relations Coordinator, State	1	14,500	14,500
Calibration Overseer, State	1	12,000	12,000
Administrator for Station Operations, Contractor	1	25,000	25,000
Inspector Training Coordinator, Contractor	1	13,000	13,000
Legal Counsel, Contractor	1	16,000	16,000
Purchasing Officer, Contractor	1	12,000	12,000
Accountant, Contractor	1	12,000	12,000
Contracts Officer, Contractor	1	12,000	12,000
Engineer, Contractor	1	16,000	16,000
Systems Analyst, Contractor	1	15,000	15,000
Calibration Investigators, State	5	12,000	60,000
Complaints Investigators, State	10	12,000	120,000
Fleet Calibration Coordinators, State	5	12,000	60,000
Labor Relations Officials, Contractor	5	15,000	75,000
Instrument Repair Technicians, Contractor	5	15,000	75,000
Public Relations Officials, Contractor	5	12,000	60,000
Calibration/Maintenance Coordinators, Contractor	5	12,000	60,000
Regional Managers	5	17,500	87,500
Total salaries			919,000
25 percent overhead			229,750
			1,148,750

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*This contractor will be separate from the "contractor" noted elsewhere.

Public Information--

In addition to an intensive preimplementation effort, a comprehensive annual public information program will be required to maintain a high degree of public awareness and support to the program. A contractor from another state has suggested $0.12 per test to be performed as a reasonable estimate of the anticipated expenditure. The average projected vehicle population for 1982 through 1987 is 8,251,000; this translates to 9,901,000 inspections annually, assuming a 20 percent failure rate. The cost then for an annual public information program can be calculated:

(9,901,000 inspections/yr)($0.12/inspections) = $1,188,120

Personnel Training--

This element reflects the ongoing requirement to train new inspectors. The replacement rate, which is the number of inspectors added each year, was estimated to be 10 percent, based on the experiences of other states. An inspector work force of 865 was previously derived, translating to 87 new inspectors annually. The cost of training a new inspector was previously found to be $16.00, therefore, the entire cost is:

87 persons at $16/person = $1,392.00

Summary

Itemized costs for the entire program were classified by primary fiscal responsibility; costs are expected to be met by the State of Ohio, the primary contractor, and secondary contractors. In some instances, such as the one-time startup costs, the Ohio EPA may obtain funds through appropriations by the Ohio General Assembly, Federal grants, and/or other sources as provided by the General Assembly. The detailed cost summary is provided in Table 39.

FEE COMPUTATION

Annualized Costs

In order to devise a "break-even" fee, all costs found in Table 39 are converted into annual figures. The steps involved in calculating these annual costs and the fees are summarized below.

Initial Capital Costs--

The primary elements associated with this category are the costs associated with land, buildings, and equipment. These costs were computed in constant 1978 dollars using appropriate amortization factors.

Since land yields services in perpetuity, the amortization factor is assumed to be the marginal rate of return on capital. This factor, then, is sensitive to the source of financing (i.e., equity, debt, or taxes). For this analysis, a factor of 0.06 is assumed.

TABLE 39. COST SUMMARY

Primary category - principal element	Cost responsibility ($)			Total element cost ($)	Total category cost ($)
	State	Primary contractor	Secondary contractor		
I. Initial Capital Costs					
1. Building investment		23,450,564		23,450,564	
2. Land investment		6,260,571		6,260,571	
3. Equipment investment		25,379,500		25,579,500	
					55,290,635
II. One-Time Startup Costs					
1. Land acquisition		1,040,533		1,040,533	
2. Facilities planning		3,517,000		3,517,000	
3. Program design	150,000			150,000	
4. Software development		200,000		200,000	
5. Personnel training	1,180	22,869		24,049	
6. Personnel salaries/overhead	534,375	2,884,543	16,250	3,435,168	
7. Public information	50,000	1,138,120		1,188,120	
8. Mechanics training			106,350	106,350	
	735,555	8,803,065	122,600		9.661,220
III. Annual Operating Costs					
1. Personnel		13,070,000		13,070,000	
2. Maintenance		4,558,900		4,588,900	
3. Utilities/services/supplies		5,963,765		5,963,765	
		23,592,665			23,592,665
IV. Annual Administrative Costs					
1. Personnel	534,375	598,125	16,250	1,148,750	
2. Vehicle operation	36,000			36,000	
3. Public information		1,188,120		1,188,120	
4. Personnel training		1,392		1,392	
	570,375	1,781,637	16,250		2,374,262

Structures are assumed to have a 20-year service life and to yield equal service throughout this period. The annual cost of each dollar invested in structures, then, is: $\frac{i}{1-(1+i)^{-20}}$

Similarly, equipment is assumed to provide service for 5 years, thus the annual cost per dollar invested in equipment is: $\frac{i}{1-(1+i)^{-5}}$

One-Time Startup Costs--

One-time startup costs, like capital costs, are incurred only during initial startup. The startup costs are recouped over the first 5 years of the project. Thus, the annual cost of each dollar of expenditures is the same as that for capital equipment: $\frac{i}{1-(1+i)^{-5}}$

Annual Operating and Administrative Costs--

These costs are already presented as annual amounts. These amounts must be added to the annualized capital and startup costs, to arrive at the total annual cost of the whole project.

Annualized costs for each of the four categories are shown in Table 40.

Effects of Inflation--

In order to eventually derive an estimate of the actual fee, which will be uniform in actual dollars over time, the effects of inflation must be considered. In this connection, it is assumed that inflation is 7 percent annually. The effect, then, is that the amortization factors used must reflect the market rate of interest, which is equal to the real rate of return on capital, (defined previously as 6 percent), plus the rate of inflation. The annualized costs then, reflecting inflation can be computed. These are shown in Table 41.

Fee Calculation

With the cost data developed above, two fees can be computed. The first fee, f_c, reflects the annual costs in real 1978 dollars. The second fee, f_a, in actual dollars, reflects the impact of inflation. These fees, calculated simply as the total annualized cost divided by the number of annual registrations (expected to be 8.251 million per year on the average over 5 years), are presented in Table 42. The break-even fee does not reflect a profit to the contractor. The profit would be worked out between the selected contractor and the State of Ohio. However, it should be noted that the break-even fee does reflect a return on investment of 6 percent for the land buildings and equipment. This does not include an estimated rate of inflation which has been included in the actual dollar (f_a) calculation. This percent is the return which an investor

TABLE 40. ANNUALIZED COSTS IN CONSTANT 1978 DOLLARS

	Cost category	Cost ($)	Amortization factor (i=0.06)	Annualized cost ($) (column 2 × column 3)
I.	Capital Costs			
	1. Land	6,260,571	0.06	375,634
	2. Buildings	23,450,564	0.0870	2,040,199
	3. Equipment	25,579,500	0.2374	6,072,573
II.	Startup Cost	9,661,220	0.2374	2,293,574
III.	Operating Costs	23,592,665	1.0	23,592,665
IV.	Administrative Costs	2,374,262	1.0	2,374,262
	Total			36,748,507

TABLE 41. ANNUALIZED COSTS IN ACTUAL DOLLARS

	Cost category	Cost ($)	Amortization factor (i=0.06)	Annualized cost ($) (column 2 × column 3)
I.	Capital Costs			
	1. Land	6,260,571	0.130	813,874
	2. Buildings	23,450,564	0.142	3,329,980
	3. Equipment	25,579,500	0.284	7,264,578
II.	Startup Costs	9,661,220	0.284	2,743,787
III.	Operating Costs	23,592,665	1.210	28,547,125
IV.	Administrative Costs	2,374,262	1.210	2,872,857
	Total			45,572,201

would expect to make to induce him to invest money in these commodities as opposed to other alternatives. The profit in excess of this is an additional inducement for the contractor for his risk taking. This profit has been included in other I/M programs such as in Arizona and California.

TABLE 42. BREAK-EVEN FEES IN CONSTANT 1978 DOLLARS AND ACTUAL DOLLARS

Classification	Total annualized costs ($)	Projected registrations	Break-even fee ($)
Constant 1978 dollars	36,748,907	8,251,000	4.45
Actual dollars	45,572,201	8,251,000	5.52

If the profit were 10 to 15 percent of the breakeven fee shown above in actual dollars ($5.52), then the total fee would range from $6.07 to $6.35.

SECTION 9

IMPLEMENTATION PLANNING

INTRODUCTION

In view of the complex and controversial nature of inspection/maintenance programs, careful implementation planning is crucial for overall program success. Implementation planning consists of coordinating and scheduling various activities such as passage of necessary enabling legislation and securing the needed funding, arranging for the selection of a contractor(s) to design, construct, and/or operate the inspection facilities, etc. Together, all these activities are needed to bring the program from conceptual plans to actual operation, with mandatory inspection/maintenance. With regard to program success, a distinction can be made between success in terms of (1) accomplishing all those tasks that result in the program being operational by the specified deadlines and designed and constructed to operate efficiently, and (2) the public's acceptance and recognition of the program as an essential mechanism for achieving a cleaner and healthier environment.

Meeting the deadline and establishing efficient operation depend largely on the effectiveness of the physical planning (construction planning and scheduling, equipment purchases, etc.). Public acceptance depends to a large degree on the successful planning and implementation of adjunctive programs (public relations, quality assurance, consumer protection, etc.); this is the area of policy and program planning. Both of these elements, physical and program planning and their relation to overall program implementation, will be discussed in this section.

Three types of deadlines and implementation events will be discussed. First, the U.S. Environmental Protection Agency has set policy guidelines that directly affect the schedule and phase-in requirements of the program. These concern primarily the dates when the program has to be implemented and operating fully. Second, there exists a general sequence to the efforts that will be undertaken in connection with implementing the program that, even though quite logical and perhaps very obvious, will be mentioned here for completeness. Third, there are several issues relating to either scheduling or phase-in that are quite subtle and have a potential impact on the program. These types of issues have been identified through discussions with individuals who have been involved in the implementation and/or operation of I/M programs and have the valuable insights that are obviously gained through such experience.

FEDERAL I/M SCHEDULE REQUIREMENTS

Those aspects of I/M implementation policy which require the most immediate attention on the part of the State of Ohio are those for which the U.S. EPA has set deadlines as part of the State Implementation Plan (SIP) revision and review process mandated by the Clean Air Act Amendments of 1977. Since the I/M program is one element of the SIP, there is obviously a strong connection between SIP revision requirements and the tasks which must be accomplished as parts of Ohio's I/M implementation schecule. The U.S. EPA has defined quite carefully those tasks which must be accomplished by the states in order to satisfy SIP revision requirements; these revisions must be submitted on or before 1 January 1979. The following list of tasks, which comprise a recommended I/M implementation schedule, was issued by the U.S. EPA in a policy memorandum dated 17 July 1978.

"The I/M Implementation Schedule

The specific items listed below must be included as a part of the States' I/M implementation schedules with specified dates for implementation of each item. The stringency planned for the program and other factors affecting the potential for emission reductions should also be indicated. Additional items if necessary because of local factors may be required by U.S. EPA Regional Offices.

1. Initiation (or continuation) of public information program including publicizing the I/M program in the media, meeting and speaking with affected interest groups, etc.

2. Preparation of a draft legislative package and submittal of legislation package to legislature if additional legislative authority is needed.

3. Certification of adequate legal authority by appropriate state official.

4. Initial notification of garages explaining program and schedule of implementation.*

5. Development and issuance of RFPs.*

6. Award to contractor(s).*

7. Initiation of construction of facilities.*

8. Completion of construction of facilities.*

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*Indicates that items may apply to some I/M programs and not to others.

9. Adoption of procedures and guidelines for testing and quality control including emission analyzer requirements (and licensing requirements for private garages, if applicable).*

10. Notification of and explanation to garages of actions in Step 9.*

11. Completion of equipment purchase and delivery of equipment.

12. Development and adoption of cutpoints.

13. Initiation of hiring and training of inspectors or licensing of garages.*

14. Initiation of introductory program (voluntary maintenance with either voluntary or mandatory inspection) if not previously initiated.

15. Initiation of mechanics training and/or information program.

16. Initiation of mandatory inspection.

17. Initiation of mandatory repair for failed vehicles.

If certification of adequate legal authority occurs after January 1979, the States may modify previous commitments to implement and enforce the elements of the schedule to conform to the legal authority.* These modifications will be approved by the EPA Regional Offices and must be consistent with the Administrator's February 24, 1978, policy memorandum. The documents should be submitted by January 1, 1979. Any necessary adjustments to the schedule may be made at this time but must be approved by the EPA Regional Offices."

DISCUSSION OF I/M IMPLEMENTATION SCHEDULE ELEMENTS

The following discussion considers the U.S. EPA elements listed above as well as other tasks that are important to the successful implementation of an I/M program in Ohio. Table 43 summarizes these tasks and gives anticipated dates for their completion.

Preliminary Planning

The initial planning of the I/M program, of which this report is a key element, consists of two tasks:

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*Indicates that items may apply to some I/M programs and not to others.

TABLE 43. OHIO I/M IMPLEMENTATION SCHEDULE

	1978	1979				1980				1981				1982	
	4th QTR	1st QTR	2nd QTR	3rd QTR	4th QTR	1st QTR	2nd QTR	3rd QTR	4th QTR	1st QTR	2nd QTR	3rd QTR	4th QTR	1st QTR	2nd QTR
PRELIMINARY PLANNING															
A. FORMULATE TENTATIVE PLANS FOR THE FORMAT, SCOPE, DESIGN, AND OPERATION OF THE I/M PROGRAM.	■														
B. DEVELOP AN IMPLEMENTATION SCHEDULE THAT WILL ADDRESS ALL EPA SIP REQUIREMENTS	■														
ENABLING LEGISLATION AND DRAFT BUDGET															
A. DEFINE TECHNICAL AND ADMINISTRATIVE ISSUES TO BE ADDRESSED BY ENABLING LEGISLATION	■														
B. PREPARE DRAFT ENABLING LEGISLATION	■														
C. PREPARE PROGRAM BUDGET REQUEST	■														
D. LEGISLATIVE DEBATE AND APPROVAL OF LEGISLATION AND BUDGET		■													
PUBLIC INFORMATION PROGRAM															
A. DEVELOP PROGRAM STRATEGY	■														
B. DEFINE DETAILS OF FIRST STAGE OF THE PUBLIC INFORMATION PROGRAM AND IMPLEMENT	■	■													
C. DEFINE DETAILS OF THE SECOND STAGE OF THE PUBLIC INFORMATION PROGRAM AND IMPLEMENT								■	■	■	■	■	■		
D. DEFINE DETAILS OF THE THIRD STAGE OF THE PUBLIC INFORMATION PROGRAM AND IMPLEMENT														■	■
SELECTION OF CONTRACTOR															
A. PREPARE DETAILED RFP				■											
B. INTERESTED FIRMS PREPARE RESPONSE TO RFP				■											
C. STATE EVALUATES PROPOSALS AND AWARDS CONTRACT					■										

TABLE 43 (continued)

	1978	1979				1980				1981				1982	
	4th QTR	1st QTR	2nd QTR	3rd QTR	4th QTR	1st QTR	2nd QTR	3rd QTR	4th QTR	1st QTR	2nd QTR	3rd QTR	4th QTR	1st QTR	2nd QTR
INSPECTION NETWORK DEVELOPMENT															
A. CONTRACTOR UNDERTAKES EXTENSIVE SITE SURVEY AND ACQUISITION PROCESS					■	■									
B. CONSTRUCTION OF FACILITIES							■	■	■						
C. EQUIPMENT ACQUISITION AND DELIVERY								■	■						
D. TESTING OF CONTRACTOR EQUIPMENT									■						
ADOPTION OF CUT POINTS															
A. REVIEW DATA FROM EXISTING PROGRAMS, ADOPT INITIAL CUT POINTS								■	■						
B. REFINE CUTPOINTS BASED ON DATA COMPILED BY PROGRAM										■	■	■	■		
PERSONNEL HIRING AND TRAINING															
A. HIRE ADMINISTRATIVE PERSONNEL	■	■	■	■	■	■	■								
B. HIRE FACILITY MANAGERS								■							
C. DETERMINE DETAILS OF TRAINING PROGRAM									■						
D. HIRE INSPECTORS, BEGIN INSPECTOR TRAINING PROGRAM									■						
E. MECHANIC TRAINING PROGRAM									■	■	■	■	■	■	■
PROGRAM PHASE-IN															
A. IMPLEMENT MANDATORY INSPECTION, VOLUNTARY MAINTENANCE										■	■	■	■		
B. IMPLEMENT MANDATORY INSPECTION, MANDATORY MAINTENANCE														■	■

- Formulate tentative plans for the format, scope, design operation and implementation of the items listed in the I/M schedule requirements; this has to be accomplished by 30 November 1978 in order to define the second task.
- Develop an I/M implementation schedule that will address (at least) the relevant issues defined above for submittal as part of the revised SIP; this has to be completed prior to 31 December 1978.

Enabling Legislation and Draft Budget

Many important decisions have already been made by the Ohio Advisory Group regarding the basic elements of the I/M program. These include definition of such program characteristics as test type, organizational approach, geographical coverage, and frequency of inspections, each of which is described in Section 2, Option Definition. Other issues that still need to be defined in order to write draft legislation include retest policies, repair cost limits, fleet inspection requirements, antitampering provisions, funding, and other similar administrative issues. These issues are of immediate concern because the enabling legislation must be drafted soon enough to be included in the early 1979 legislative sessions; the U.S. EPA deadline for securing legal authority to implement and enforce the program is 30 June 1979. Consequently, in order for Ohio to meet this deadline, the necessary I/M legislation must be passed during the January to July 1979 legislative sessions. The basic tasks indicated and the dates for their completion, then, are:

- Define remaining technical and administrative aspects of the program that are necessary to be included in the enabling legislation; this should be accomplished by 30 November 1978.
- Prepare enabling legislation; this should be completed during December 1978.

In a very similar connection, a program budget must be derived very soon in order to secure the funds necessary to implement and operate the program by the scheduled deadlines. This establishment of the required funding is also a legislative process and, therefore, must also occur during the early 1979 State Legislative Session. This obviously requires the preparation of a budget estimate and substantiating documentation, probably by the I/M Task Force. The specific task, then is:

- prepare program budget request including actual estimates and substantiating data; this should be accomplished prior to 1 January 1979.

To carry this discussion a step further, the legislation and budget must be approved by the State Legislature as a prerequisite for the advancement of the program beyond the conceptual stage. It is unfortunate that there are no checklists that can be followed or procedures that can be recommended to guarantee rapid approval of the proposed legislation and budget by the State Legislature. EPA guidance, however, is rather specific with regard to the scheduling requirements for securing the proper authority to implement I/M, as can be seen in the following excerpt from an EPA policy memorandum dated 17 July 1978:

"Authority to Implement I/M

> Normally, adequate legal authority to implement a SIP revision must exist for a revision to be approved. Where a legislature has had adequate opportunity to adopt enabling legislation before January 1, 1979, the Regional Administrator should require certification that adequate legal authority exists for I/M implementation by January 1, 1979. However, for many states there will be insufficient opportunity to obtain adequate legal authority before their legislatures meet in early 1979. Therefore, a certification of legal authority for the implementation of I/M in these states must be made no later than June 30, 1979. An extension to July 1, 1980, if possible, but only when the state can demonstrate that (a) there was insufficient opportunity to conduct necessary technical analyses and/or (b) the legislature has had no opportunity to consider any necessary enabling legislation for inspection/maintenance between enactment of the 1977 Amendments to the Act and June 30, 1979. Certification of adequate legal authority, or other evidence that legal authority has been adopted, must be submitted to the EPA Regional Offices to be included in the SIP revision already submitted. Failure to submit evidence of legal authority by the appropriate deadline will constitute a failure to submit an essential element of the SIP, under Sections 110(a)(2)(I) and 176(a) of the Act."

It is entirely likely (and logical) that during discussion regarding the I/M legislation the question will arise as to: what will happen if we do not approve I/M legislation by the 31 June 1979 deadline? The answer to this is that the State would not be able to submit an essential element of the SIP, and that Sections 110(a)(2)(I) and 176(a) of the Act would apply. Of particular interest are the provisions of Section 176(a), which deal with sanctions that may be placed against states for noncompliance; this Section is excerpted below:

LIMITATIONS ON CERTAIN FEDERAL ASSISTANCE

SEC. 176. (a) The Administrator shall not approve any projects or award any grants authorized by this Act and the Secretary of Transportation shall not approve any projects or award any grants under title 23, United States Code, other than for safety, mass transit, or transportation improvement projects related to air quality improvement or maintenance, in any air quality control region—

(1) in which any national primary ambient air quality standard has not been attained,

(2) where transportation control measures are necessary for the attainment of such standard, and

(3) where the Administrator finds after July 1, 1979, that the Governor has not submitted an implementation plan which considers each of the elements required by section 172 or that reasonable efforts toward submitting such an implementation plan are not being made (or, after July 1, 1982, in the case of an implementation plan revision required under section 172 to be submitted before July 1, 1982).

(b) In any area in which the State or, as the case may be, the general purpose local government or governments or any regional agency designated by such general purpose local governments for such purpose, is not implementing any requirement of an approved or promulgated plan under section 110, including any requirement for a revised implementation plan under this part, the Administrator shall not make any grants under this Act.

(c) No department, agency, or instrumentality of the Federal Government shall (1) engage in, (2) support in any way or provide financial assistance for, (3) license or permit, or (4) approve, any activity which does not conform to a plan after it has been approved or promulgated under section 110. No metropolitan planning organization designated under section 134 of title 23, United States Code, shall give its approval to any project, program, or plan which does not conform to a plan approved or promulgated under section 110. The assurance of conformity to such a plan shall be an affirmative responsibility of the head of such department, agency, or instrumentality.

(d) Each department, agency, or instrumentality of the Federal Government having authority to conduct or support any program with air-quality related transportation consequences shall give priority in the exercise of such authority, consistent with statutory requirements for allocation among States or other jurisdictions, to the implementation of those portions of plans prepared under this section to achieve and maintain the national primary ambient air quality standard. This paragraph extends to, but is not limited to, authority exercised under the Urban Mass Transportation Act, title 23 of the United States Code, and the Housing and Urban Development Act.

The implications of not approving I/M legislation are quite severe, as can be seen from Section 176(a), and therefore should be considered in legislative discussions on the proposed legislation.

The basic task, then, is:

- Approve I/M legislation and corresponding funding; this in general should be accomplished prior to 31 June 1979, but considering the dates that the Legislature is in session, approval should occur during January or February 1979.

Public Relations Program

The third element to be discussed concerns the initiation of a public information program regarding I/M. In deciding on the particular program details, several points should be considered. First, there are three basic stages in the public information effort and the activity and timing of each should be treated carefully. The first stage occurs during the period prior to the introduction of draft legislation to the Legislature, and extends through the time that the legislation is approved. The purpose of this stage is to inform the public concerning the basic concepts of the program, primarily to develop support from those individuals whose representatives will be acting on the legislation in the State Legislature. The primary effort may be directed more toward organized groups who have both a recognized lobbying power and an inherent interest in promoting air pollution reduction. The second phase occurs approximately 6 months to a year prior to the startup of the program and extends through the first year of operation. This stage requires a very strong, visible effort to inform the public about the details of the I/M program, particularly concerning the benefits that the individual motorist is likely to derive from the program. Also, the intent of this stage should be to define the requirements for each motorist in detail so that essentially all motorists know what to expect, with regard to how they are notified, as to when and where they will be inspected, exactly what their repair liability will be (repair cost ceilings), where they can take their vehicles for repairs if required, etc. The final stage is a continued effort after the I/M program is operating smoothly. The intent of this stage would be to inform the public of the program's effectiveness in reducing pollution. This stage would require a somewhat lower level of effort than would the second stage.

The tasks associated with public relations programs, then, can be described as follows:

- Develop public relations program strategy, level of activity associated with each phase, implementation dates (approximate) of each phase, etc.; this planning effort should be completed prior to 30 November 1978.

- Define details of the first stage of the public information program and implement and conduct same; this should occur during the period from approximately 1 November 1978 to 1 March 1979 (or until legislation is adopted).

Selection of Contractor

Once legislation and a program budget have been debated and adopted, the next step in the implementation process is the selection of a contractor to construct and operate the statewide network of inspection stations. Specifically, this step involves developing and issuing requests for proposals (RFP's), receiving proposal(s) from one or more interested firms, evaluation of these proposals, and subsequent award of contract(s) to one or more of those firms submitting proposals. The individual tasks associated with this implementation element are as follows:

- Preparation of request for proposal, since this task could not be undertaken until after the legislation and budget were approved, and would involve development of a highly detailed document specifying exactly the requirements of the contractor, this task would begin around 1 July 1979 and would probably take 2 months to complete.
- Issuance of request for proposal to interested firms could probably occur in early September 1979.
- Evaluation of proposals and selection of contractor; assuming proposals from interested contractors are received by 1 October 1979, and the evaluation/negotiation process to select a contractor takes 2 months to complete, then a contract (also a highly detailed document) could be drawn up and signed by 1 December 1979.

Network Construction

The next step in the implementation process after selection of a contractor is the actual construction by the contractor of the inspection network. Based on preliminary studies in this report, this step will be a massive undertaking, requiring construction of over 100 separate facilities costing over $50 million. The individual tasks associated with this implementation element are as follows:

- Contractor begins extensive site survey and acquisition process, which will probably take 6 months, from December 1979 to March 1980.
- Contractor would initiate construction of the entire network in Spring 1980; facilities should be completed by December 1980.
- Contractor selects and purchases (or designs and manufactures) inspection equipment in accordance with state specifications. It should be expected that a fairly substantial lead time would occur between ordering and delivery of highly sophisticated equipment such as computer systems and chassis dynamometers; construction scheduling could be set up, however, so that this equipment was delivered in the latter stages of the construction period, so the equipment could be installed as it arrived. Equipment delivery would occur between June and December 1980.

- Contractor conducts tests of equipment to guarantee that the network will be operational by 1 January 1981.

Adoption of Cut Points

The next step in implementation of the program is the development and adoption of cut points, the levels of emissions at which a vehicle will fail inspection. The cut points are an extremely important element of the program, as they define to a large extent the extent of air quality benefits to be achieved by the program, as well as the magnitude of the repair costs to be borne by the public. Initial cut points can be selected based on vehicle emissions data compiled by other states, and can be refined during the early stages of the program once a sufficient cross section of the Ohio vehicle population has been tested. Specific tasks include:

- Review data from other programs, define initial cut points; this can take place during the period 6 to 9 months prior to program startup.

- Refine cut points to account for Ohio-specified data and changing vehicle emissions characteristics; this task occurs approximately 6 months after initiation of testing and continues throughout the program as an ongoing process.

Hiring and Training Personnel

Once facilities have been constructed, the contractor will begin an intensive program to hire and train inspectors and other station personnel; close to 1000 such employees will be required to operate the statewide network. Administrative personnel will also be hired to run the program.

Administrative personnel would be phased into the program 30 months prior to beginning the testing while operating personnel, managers and inspectors would be phased in 6 months and 1 month prior to startup, respectively. Training courses for inspection personnel would begin approximately 6 months prior to startup to train all new personnel, and the training would continue throughout the program to train additional personnel being brought into the system. The mechanics training program would begin approximately 6 months prior to mandatory maintenance. A task that must be carried out prior to implementing mechanic training is to define the nature of the training program in terms of who will do the testing, what will be taught, etc. The specific tasks involved include:

- Hire administrative personnel, this would be accomplished 12 months prior to program startup.

- Hire inspection facility managers and assistant managers, this would be accomplished 6 months prior to startup.

- Determine training program details including scope, who will conduct training, where training is to be held, etc.; this would be accomplished 1 year prior to startup.
- Begin mechanics/inspector training program; this would begin 6 months prior to beginning any testing (inspector training phase would begin 1 month prior to startup.

Program Phase-In

The final items on the implementation schedule concern the phase-in of mandatory inspections and mandatory maintenance. This report endorses a full year of mandatory inspections and voluntary maintenance prior to full mandatory maintenance; it is felt that at least one full registration cycle should be completed to acclimate the state's population to the program; equity problems might arise if the voluntary maintenance period were shorter than the intial year of operation. It is also felt that this initial year of voluntary maintenance would be an ideal opportunity to shake down the system, recognize all potential problems, and take corrective actions to resolve them. This proposal, however, should be considered in light of a U.S. EPA guidance memorandum dated 17 July 1978, which states:

> D. "I/M Implementation Deadlines
>
> Implementation of I/M "as expeditiously as practicable" shall be defined as implementation of mandatory repair for failed vehicles no later than two and a half years after passage of needed legislation or certification of adequate legal authority for new centralized systems and one and a half years after legislation or certification for decentralized systems or for centralized systems which are adding emission inspections to safety inspections. For the normal legislation deadline of June 30, 1979, new centralized programs must start by December 31, 1981, and all others must start by December 31, 1980. For the case of the latest possible legislation date, July 1, 1980, this means that a new centralized program must start by December 31, 1982, while all other programs must start by December 31, 1981. Where I/M can be implemented more expeditiously, it must be. Each state implementation schedule must be looked at individually to determine if it is as expeditious as practicable. Implementation dates ordered by courts, if earlier than these dates, take precedence."

As can be seen in Table 43, the 31 December 1981 deadlines stipulated by this paragraph would allow for a full year of mandatory inspection and voluntary maintenance if all the construction deadlines above were met on schedule.

Although the Ohio I/M Advisory Group has recommended that the entire system be constructed at once, with a 1-year period of voluntary maintenance, it should be recognized that there are a variety of different methods through which a program can be phased in. These include progressively stringent cut points, expanding geographic coverage, and expanding coverage of different vehicle types.

Progressively Stringent Cut Points--
Vehicle emission standards or "cut points" determine the overall emissions reduction potential of an I/M program; as such, they distinguish between those vehicles requiring emissions-related maintenance and those which do not. The principal objective of an I/M program is to achieve maximum reductions of automotive pollutants; this objective, however, must be balanced against considerations of public convenience and repair industry capacity. Implementing progressively stringent cut points is one means of achieving this balance.

Experience from various states implementing I/M programs shows that, despite a very exhaustive research program to establish cut points, it is very difficult to predict accurately the number of vehicles which will fail their initial test. This number is dependent on the overall automotive maintenance habits of the population, a factor which is difficult, if not impossible, to predict. Should a large fraction (higher than anticipated) of the vehicle population fail the initial test, a negative public sentiment could develop that would jeopardize the program's success. Further difficulties could arise if the total of noncomplying vehicles exceeds the available capacity of the automotive repair industry. These problems, of course, can be alleviated by setting initial standards such that only the "gross emitters" will fail. Both the public and the repair industry are then afforded the opportunity to become accustomed to the program and its economic effects before standards are in full force.

It should be noted that a system of voluntary maintenance for a given period (one registration cycle, for example) would achieve similar effects; furthermore, since maintenance would not be required, experimentation with different test standards in different facilities could be undertaken to determine the overall failure rates associated with various cut points.

Expanding Geographic Coverage--
A policy memorandum from the U.S. EPA, dated 17 July 1978, details the minimum acceptable geographic coverage for an I/M program as not only the designated nonattainment area, but also certain areas beyond, including "the entire urbanized area and adjacent fringe areas of development." Eighteen counties in Ohio with urbanized populations of 200,000 or greater have been designated as nonattainment areas, but in reality, 63 out of the entire 88 counties in the state regularly exceed the National Ambient Air Quality Standards (NAAQS). The vehicle population of Ohio is not densely packed into one or two major urban areas; rather, it is spread throughout the state. For these reasons, as well as equity considerations, a statewide program, as recommended by the I/M Advisory Group, seems justified.

A policy in which the urbanized stations are constructed first, and rural stations were constructed once the urban stations were operational, would satisfy U.S. EPA requirements. Such a policy would create problems, however; Ohio motorists would be given a perverse incentive to register their cars only in rural counties to escape program requirements. Such a policy might also create cash flow problems for the contractor, who is relying on total system revenue to meet interest payments on outstanding debts, since the urban stations are the largest and most expensive to construct. Further, greater economies of scale in construction can be realized if the system is constructed all at once.

Expanding Coverage of Different Vehicle Types--

Given U.S. EPA policy guidelines that require at least a 25 percent reduction in light-duty vehicle (LDV) exhaust emissions of HC and CO by 1987, it is obvious that the burden of responsibility for emissions inspection and maintenance will fall upon the LDV population. Definition of this population is flexible, up to a point. Once maximum weight limits are set by policy decisions (the I/M Advisory Group has set this limit at 8,500 lb GVW or 3,864 kg), the inspectable vehicle population may be defined, and facilities designed to handle this population. So long as inspection facilities are designed to handle a certain motor vehicle population over a period of years, it is not practical to phase in additional vehicle types. It is more cost-effective from the contractor's viewpoint, and more equitable from the state's viewpoint, to initiate a testing program for all the vehicles in the design population.

SECTION 10

SUMMARY

INTRODUCTION

Need for Inspection/Maintenance Programs

Recent ambient air quality data for the State of Ohio indicate widespread and frequent violations of the National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO) and photochemical oxidants (O_x) in 63 counties.[1] These national standards have been established in order to protect the public health and welfare of the population.[2] Both CO and O_x are gases which in sufficient concentrations in the atmosphere are potentially harmful to the public health. A major source of CO and O_x in Ohio is its motor vehicle population. Carbon monoxide is directly produced by gasoline-burning internal combustion engines, and photochemical oxidants are indirect products, formed through a complex series of atmospheric reactions in which two other direct products of combustion, unburned gaseous hydrocarbons (HC) and oxides of nitrogen (NO_x), combine in the presence of sunlight. An inspection/maintenance program is a cost-effective strategy to reduce these pollutant emissions from motor vehicles. Other strategies that have been suggested, such as restricting vehicle travel, are more difficult to enforce, tend to reduce individual mobility, and may require major changes in driving habits. By significantly reducing the emission of HC and CO from in-use motor vehicles in Ohio, an I/M program will enhance the likelihood of the attainment of NAAQS.

The Clean Air Act Amendments of 1977 have specific provisions that require the establishment of inspection/maintenance programs. According to the Act, the state must submit by January 1979 revisions to its State Implementation Plan (SIP), which specifies methods to achieve the National Ambient Air Quality Standards. These methods include control of stationary sources of air pollution and various transportation control measures whose objective is to reduce vehicle miles traveled (VMT) and hence reduce pollution from sources such as motor vehicles. If, in these revisions, the state cannot demonstrate attainment of the NAAQS by 1982 by using all reasonably available pollution control measures, then an extension to 1987 can be requested if several provisions are met. One such provision is the establishment of a specific schedule for the implementation of an I/M program. Because it is doubtful that the NAAQS can be attained in many areas of Ohio through other measures, an I/M program is likely to be required.

What are Inspection/Maintenance Programs?

In the inspection phase of I/M the motor vehicle exhaust emissions are measured and compared to the applicable standards for the vehicle. If the vehicle fails the exhaust emission test then it must be repaired so as to reduce its emissions to the applicable standard. This is the maintenance phase of I/M.

The Federal Motor Vehicle Emission Control Program (FMVECP) under the Federal Clean Air Act of 1970 was established to ensure that new cars coming off the assembly line are designed to meet increasingly stringent emission standards. The FMVECP consists of three parts, including certification of prototype vehicles prior to actual production, selective envorcement testing of vehicles at the assembly line, and testing of in-use vehicles around the country to discover design defects in emission controls as well as to provide data to recall vehicles with inadequate or defective emission devices. Federal testing of in-use vehicles are in general not meeting the emission standards for which they are designed. The primary reasons these vehicles are exceeding the standards include improper or inadequate maintenance, tampering, and defective emission control devices. Regardless of the cause, it has become clear that some sort of in-use vehicle emission inspection programs are necessary to ensure that the emission control continue to operate as they were intended over their useful life.

A variety of approaches have been used to run I/M programs, but the major types are generally in three organizational categories as follows:

1. Government - Centralized test facilities operated by state, city, or local government (as in New Jersey; Cincinnati, Ohio; Portland, Oregon; and Chicago, Illinois).

2. Contractor - Centralized facilities operated by a private corporation under contract to a government (as in Maricopa and Pima Counties, Arizona).

3. Private Garage - Decentralized facilities operated by private automobile service garages, certified or licensed by a government (as in Rhode Island and Nevada).

The major issues that need to be addressed in setting up an I/M program include the following:

1. Type of Emissions Test (Idle or Loaded - simulating driving conditions).

2. Geographical Coverage (Statewide or selected regions of the state)

3. Organizational Approach (Government, contractor, or private garage)

4. Frequency of Inspection (e.g., twice a year or once a year)

5. Enforcement Procedure (Withholding registration or sticker/ticketing)

The other program areas or issues which will require more attention in the detailed evaluation of the selected option and also during the program design phase are the following:

1. Type(s) of Motor Vehicles Included in Program (Section 3)
2. Vehicle Exemptions (Section 3)
3. Data Handling (Section 3)
4. Mechanic Training (Section 6)
5. Quality Assurance (Section 6)
6. Consumer Protection (Section 6)

Background of This Study

In order to meet the requirements of the Clean Air Act Amendments of 1977 in establishing a schedule of implementation for an I/M program in Ohio, the Ohio Inspection/Maintenance Advisory Group was established early in 1978. The federal guidelines for inspection/maintenance programs are presented in Appendix C. The Ohio I/M Advisory Group met in March 1978 to initiate action on considering various possible I/M options and to select the option most suited to the needs and desires of the State of Ohio. The Advisory Group is composed of members of various agencies including representatives of the Ohio Environmental Protection Agency, the Department of Highway Safety which includes the Bureau of Motor Vehicles and the State Highway Patrol, the Department of Transportation, the Attorney General's Office, the Governor's Office, and the Department of Energy.

The initial effort of the Advisory Group was the development of data regarding the technical and administrative aspects of I/M programs. There have been several sources of data used by the Advisory Group that has been helpful in their decisions. Among them were executive workshop trips to study existing I/M programs in Cincinnati, Ohio; Portland, Oregon; and Phoenix, Arizona. The staff of the Ohio EPA has maintained contact with many of the I/M programs throughout the country and this has been provided useful information. Finally, the consultant responsible for this report and the earlier reports discussed below provided significant input to the Advisory Group through reports, presentations, and technical memoranda.[3,4,5]

A summary report describing I/M program elements and other state's experience in I/M and various technical memoranda was produced to assist in the selection of a limited number of I/M options.[6] In April 1978 the Advisory Group selected seven I/M program options, which were subsequently evaluated and compared in terms of benefits, costs and effectiveness.[7] Among the variables considered in looking at the different options were whether to have the state, a private contractor or licensed private garages conduct the emissions inspection; whether to have the program cover only the urbanized counties (12 to 18 counties) or tohave full statewide coverage; whether to use a simple idle test or more comprehensive loaded mode test; what enforcement procedure would be best, motor vehicle registration or using stickers and ticketing; whether or not to have the Ohio State Highway Patrol conduct a random roadside emission test for vehicles in the rural areas. The Phase II Report, then, consisted of a comparative evaluation of the seven options listed in Table 44.

The findings of this report indicated that a state- or contractor-run inspection would cost the average motorist very close to the same amount differing only by about $0.20 per inspection. (The contractor would cost approximately $0.20 more because of taxes paid to local governments for its land and buildings.) The private garage approach would cost about the same as the state or contractor depending on the level of participation of private garages. As more garages participated in the program, the share of the total vehicle population coming to each station is reduced, therby requiring each station to charge higher fees to break even. In terms of emission reduction benefits, the statewide programs clearly brought greater reduction in emissions as more vehicles would be included in the statewide program. There would probably be a very similar level of reduction among the three organizational approaches, state, contractor or provate garage. The random roadside emission test procedure would not bring the same emission credits from the U.S. EPA.

Other issues were raised, however, that indicated potential indirect benefits from the centralized land approach as opposed to the decentralized garage options. Having a licensed private garage conduct both inspections and the necessary repairs for the failed vehicles, raises potentially serious conflict of interest questions. Given the adverse publicity concerning alleged unethical repair practices in the repair industry and given the technical difficulties in maintaining quality control on the several thousand emission analyzers across the state, this option was considered to have significant disadvantages in comparison to state or contractor centralized lanes. Quality control and supervision would be much better and uniformity of inspection results would consequently be far greater in centralized lanes.

Another issue that separates the options concerns the committment of large numbers of state employees. In the state-run approach there would be a far greater number of new state employees, namely, the actual emissions inspectors. This employment issue was seen as potentially significant in view of the desirability keeping the commitment of state manpower to a minimum. Moreover, the contractor approach allows for the option of state cancellation either during or at the end of the 5-year initial period if the state wanted to take over the program itself.

As a result of the findings of this report and other inputs, the Ohio I/M Advisory Group selected a final option for evaluation. A more detailed evaluation of benefits and costs of this option is the subject of this report, entitled The Phase III Report. A comprehensive outline of the final option is given below.

TABLE 44. SEVEN OHIO I/M PROGRAM OPTIONS

THE SEVEN OPTIONS ARE AS FOLLOWS:

- OPTION I
  - STATEWIDE COVERAGE
  - CONTRACTOR ADMINISTERS CENTRALIZED LANES IN URBAN AREAS
  - PRIVATE GARAGES IN RURAL AREAS
    - ALTERNATE A - 12 URBAN COUNTIES - ALL COUNTIES GREATER THAN 200,000
    - ALTERNATE B - 18 URBAN COUNTIES - 12 COUNTIES GREATER THAN 200,000 PLUS 6 ADJACENT COUNTIES
- OPTION II
  - STATEWIDE COVERAGE
  - STATE ADMINISTERS CENTRALIZED LANES IN URBAN AREAS
  - PRIVATE GARAGES IN RURAL AREAS
    - ALTERNATE A - 12 URBAN COUNTIES
    - ALTERNATE B - 18 URBAN COUNTIES
- OPTION III
  - URBAN COUNTIES ONLY
  - CONTRACTOR ADMINISTERS CENTRALIZED LANES
    - ALTERNATE A - 12 URBAN COUNTIES
    - ALTERNATE B - 18 URBAN COUNTIES
- OPTION IV
  - URBAN COUNTIES ONLY
  - STATE ADMINISTERS CENTRALIZED LANES
    - ALTERNATE A - 12 URBAN COUNTIES
    - ALTERNATE B - 18 URBAN COUNTIES
- OPTION V
  - STATEWIDE COVERAGE
  - CONTRACTOR ADMINISTERS CENTRALIZED LANES IN URBAN AREAS
  - STATE HIGHWAY PATROL CONDUCTS RANDOM INSPECTION IN RURAL AREAS
    - ALTERNATE A - 12 URBAN COUNTIES
    - ALTERNATE B - 18 URBAN COUNTIES
- OPTION VI
  - STATEWIDE COVERAGE
  - STATE ADMINISTERS CENTRALIZED LANES IN URBAN AREAS
  - STATE HIGHWAY PATROL CONDUCTS RANDOM INSPECTION IN RURAL AREAS
    - ALTERNATE A - 12 URBAN COUNTIES
    - ALTERNATE B - 18 URBAN COUNTIES
- OPTION VII
  - STATEWIDE COVERAGE
  - PRIVATE GARAGE TESTING IN URBAN AND RURAL AREAS
  - STATE OR CONTRACTOR CONDUCTS SURVEILLANCE/QUALITY CONTROL OF GARAGES

OPTION DEFINITION

The Ohio I/M Advisory Group has selected an I/M program for the state that will incorporate the following characteristics:

- Organizational Approach: System owned and operated by a private contractor.
- Geographic Coverage: Statewide.
- Test Type: Loaded mode test based on the Clayton Key Mode procedure, with emission measurements taken at three different engine speeds including idle, but pass-fail criteria based upon idle mode results only.
- Frequency of Inspection: Annual.
- Enforcement: Tied into motor vehicle registration procedures such that a vehicle failing inspection will not be allowed to register.
- Program Administration: Ohio Environmental Protection Agency, with assistance from the Ohio Department of Highway Safety.
- Stringency: 20 percent of the tested vehicle population will fail and need maintenance.
- Vehicles included in program:
  - light-duty vehicles (passenger cars)
  - light-duty trucks weighing less than 8,500 lb GVW
  - farm trucks
  - diesel-powered vehicles weighing less than 8,500 lb GVW
- Vehicle exempt from inspection
  - buses and trucks weighing over 8,500

    Gasoline engines driving heavy-trucks and buses contribute roughly one-fourth of the total hydrocarbon and carbon monoxide emissions in Ohio. Diesels emit particulates and sulfur dioxide (for which there are currently no standards) but no significant amounts of CO or HC. Preliminary analysis of the benefits and costs of constructing and operating special centralized lanes for heavy-duty trucks and buses (gasoline and diesel) indicate that this approach is not cost effective. Ohio EPA is currently studying the cost and effectiveness of centralized inspection lanes and other approaches such as fleet maintenance of these vehicles.

- motorcycles and motorized bicycles

  These vehicles are a small fraction of the total vehicle population. Inspection would require special equipment and would not bring significant benefits for the added costs.

- off the road vehicles not used on public highways

  These vehicles are largely recreation vehicles which contribute a very small fraction of the air pollution and are largely used in rural areas.

- racing cars used solely for exhibition purposes and not in public highways

  Racing cars do not have emission control equipment and do not contribute significantly to air pollution. These are the vehicles only used in bona fide races at race tracks.

- certified research vehicles

  Research vehicles may not be designed to be able to pass emission tests. Such a requirement might prevent the ability to conduct important research on various aspects of automotive engineering including emissions controls. Such vehicles constitute a very small fraction of total emissions.

- permanent four-wheel drive vehicles

  Four-wheel drive vehicles could not be tested on a dynamometer and the very small vehicle population does not justify the cost of acquiring special test equipment.

- certified "historic" (antique) vehicles

  Antique cars constitute a very small fraction of the total vehicles population and in most cases they would be unable to pass the emission test.

- Upon transfer of title, all vehicles included in the program must be reinspected.

- A certificate of compliance with state emission standards will be valid for 90 days to allow sufficient time for motorists to take the emissions test and if necessary have repairs made.

EMISSIONS INSPECTION SCENARIO

In order to illustrate how the I/M program will work and where some of the adjunctive programs tie in, the following description of the test procedure is offered. Figure 12 describes this process.

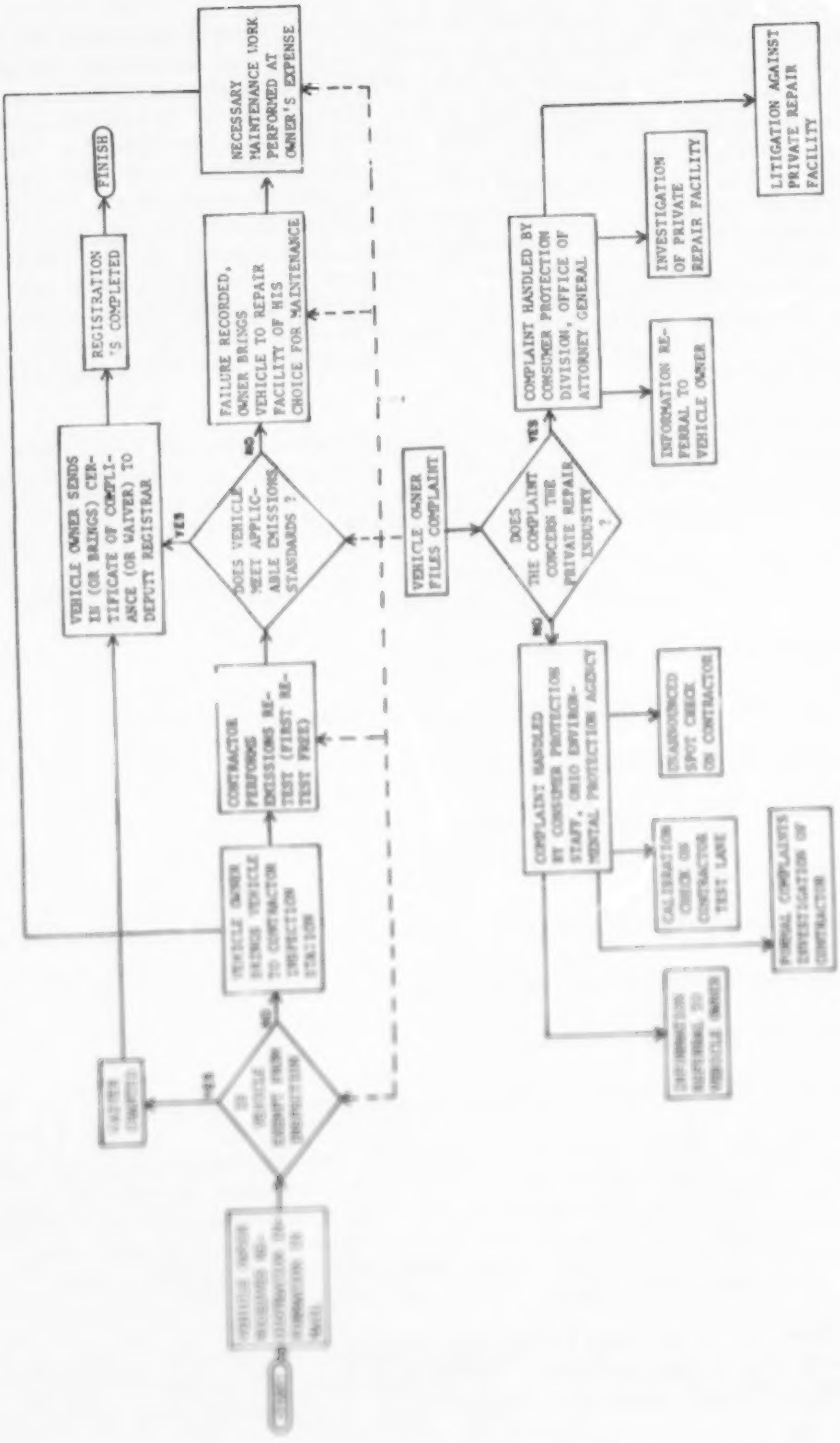

FINISH
REGISTRATION 'S COMPLETED
VEHICLE OWNER SENDS IN (OR BRINGS) CERTIFICATE OF COMPLIANCE (OR WAIVER) TO DEPUTY REGISTRAR
NECESSARY MAINTENANCE WORK PERFORMED AT OWNER'S EXPENSE
FAILURE RECORDED, OWNER BRINGS VEHICLE TO REPAIR FACILITY OF HIS CHOICE FOR MAINTENANCE
NO
YES
DOES VEHICLE MEET APPLICABLE EMISSIONS STANDARDS ?
CONTRACTOR PERFORMS EMISSIONS RE-TEST (FIRST RE-TEST FREE)
VEHICLE OWNER BRINGS VEHICLE TO CONTRACTOR INSPECTION STATION
NO
YES
WAIVER GRANTED
VEHICLE OWNER FILES COMPLAINT
DOES THE COMPLAINT CONCERN THE PRIVATE REPAIR INDUSTRY ?
YES
NO
COMPLAINT HANDLED BY CONSUMER PROTECTION DIVISION, OFFICE OF ATTORNEY GENERAL
LITIGATION AGAINST PRIVATE REPAIR FACILITY
INVESTIGATION OF PRIVATE REPAIR FACILITY
INFORMATION REFERRAL TO VEHICLE OWNER
COMPLAINT HANDLED BY CONSUMER PROTECTION STAFF, OHIO ENVIRONMENTAL PROTECTION AGENCY
UNANNOUNCED SPOT CHECK ON CONTRACTOR
CALIBRATION CHECK ON CONTRACTOR TEST LANE
FORMAL COMPLAINTS INVESTIGATION OF CONTRACTOR

Figure 12. Emissions Inspection Scenario.

The requirement for an emissions inspection in each instance will be related to the annual registration procedure; that is, emissions inspections will be required during the period when registration renewals are due. To initiate the registration renewal process, the Bureau of Motor Vehicles within the Department of Highway Safety will mail out registration renewal forms to all vehicle owners. Mailings will be staggered such that approximately one-twelfth of the total registrations are processed each month (slightly lower in winter months). From information contained in the registration renewal package, as well as media advertising carried out by the OEPA's Public Relations effort, motorists must decide whether or not their vehicles are subject to emissions inspection. If the vehicle is exempt from emissions inspection the owner either mails his registration forms or takes it in person to the Deputy Registrar where it is processed and the registration process is completed.

If his motor vehicle is not exempt from inspection, he brings his vehicle to the nearest inspection station. At the inspection station, the motorist will present his renewal forms, from which certain information will be collected and entered into a computer file. This information would include:

1. A serial number which allows the test record to be retrieved and identified with the computer;
2. Exact data and time of the test;
3. The vehicle identification number (VIN);
4. Vehicles registration number;
5. Vehicle model, year and make;
6. Owner's name;
7. Engine configuration;
8. Emissions control equipment;
9. Vehicle weight class; and
10. Test or retest number (first, second, third, etc.).

If the vehicle is not exempt, it proceeds through the test lane, where it is subjected to an emissions test. Pass-fail criteria are automatically adjusted to the particular characteristics of the vehicle. If the vehicle passes inspection, the computer prints out a certificate of compliance, which the owner either mails (or brings them in person) to the Deputy Registrar, where the registeration forms are processed.

If the vehicle fails inspection, the computer prints out a form stating which standards are being exceeded, and by how much. The owner will be advised of the probable cause for failure, and required to have the vehicle repaired and reinspected within 90 days. The owner will then bring the vehicle (and the failure form) to the repair station of his choice or repair it himself.

Then, the vehicle is repaired. The mechanic or person doing the repairs completes the repair form, stating:

1. Date of repairs;

2. Repair actions performed;

3. Parts replaced;

4. Cost of parts;

5. Cost of labor; and

6. Name and address of repair facility or person doing the repairs

The vehicle owner then brings the completed form and the vehicle back to a contractor test facility. There, the vehicle undergoes a test procedure similar to that described previously, except that no test fee is charged. If it now meets emissions standards, a certificate of compliance is printed, and the owner completes the registration process as described above.

If the vehicle fails the first retest, the vehicle owner is obliged to go through the repair and reinspection cycle once again. However, 80 to 90 percent of the vehicles pass the first retest. Generally, there is a fee for the second retest, but usually it is less than the initial test fee.

Should a motorist at any point in the above-described process have a complaint concerning either the inspection or the maintenance phase, he may register the complaint at one of two separate consumer protection agencies by calling a toll-free "hot line" telephone number. Program public information will be designed such that motorists with complaints will be advised as to which of the two numbers is appropriate under the circumstances. If the complaint concerns the inspection process or any action on the part of the contractor, it will be referred to the consumer protection function within the Ohio Environmental Protection Agency. This activity may be handled by the Division of Environmental Information within OEPA. If the complaint concerns the maintenance phase or any action on the part of the private automotive repair industry, it will be referred to the Consumer Protection Division of the Ohio Attorney General's Office.

Complaints answered by the OEPA can be handled in a variety of different ways. If the complaint is due to lack of information, the motorist could be referred to the Public Information Center of OEPA, which will then provide the motorist with more information concerning the program and its methods. If the complaint concerns actions on the part of the contractor or questions the accuracy of the contractor's equipment, the OEPA could have a mobile calibration official visit the test lane in question and check the calibration of its emissions analysis equipment, or have a complaints investigator conduct either an unannounced spot check or a formal investigation of test lane or personnel question.

If the complaints is handled by the Attorney General's Office, the procedure will be somewhat different. When the consumer contacts the hotline operator, he is sent a complaint form to fill out and return. Once the form is received, a staff member then calls the automobile dealer or repair facility in question and tries to work out the problem. If the problem cannot be resolved to the satisfaction of both parties, a member of the Consumer Protection Division's investigative staff is called on. He will then visit the facility and attempt to resolve the grievance. If a violation of law is discovered, the case is turned over to a staff lawyer for prosecution; action for restitution or damages may then be initiated.

I/M PROGRAM NETWORK

Vehicle Population Projections

An important part of this study was deriving a reasonable estimate of the number of vehicles that would actually be inspected during the period of 1982 through 1987. It was necessary to make accurate projections of the motor vehicle population for each county in order to derive the network of stations that would need to be constructed throughout the state.

To make the motor vehicle projections, detailed data on motor vehicles as well as human population growth projections were provided by the Ohio Department of Highway Safety, Bureau of Motor Vehicles and the Ohio Environmental Protection Agency. Rather than using simple projections of the existing motor vehicle population, the approach utilized here projected human population figures and multiplied figures by estimates of the inspectable motor vehicle population per capita. This resulted in the projection of the motor vehicle population shown below in Table 45.

TABLE 45. INSPECTABLE VEHICLE POPULATION ESTIMATES FOR 1982 AND 1987

OEPA Region	1982	1987
Northwest	1,388,000	1,540,000
Northeast	2,856,000	3,167,000
Central	934,000	1,036,000
Southeast	789,000	876,000
Southwest	1,862,000	2,065,000
Total	7,829,000	8,684,000

Then, to arrive at the number of actual inspections per year, the vehicle population was increased by 20 percent to account for retests of failed vehicles. This resulted in the annual inspections per year as shown in Table 46.

Network of Inspection Facilities

There is considerable variation in the number of vehicles projected for 1982 and 1987 from region to region. In the highly urbanized regions, such as Northeastern Ohio, the concentrations of inspectable vehicles per county is very high; as a result, the vehicle inspection stations have been designed to operate on a high volume basis. These stations, called urban stations, are typically multi-lane stations that are designed to utilize highly automated emissions analysis equipment and a 3-stop assembly line approach to maximize inspection efficiency. At normal efficienty such as urban facility should be able to process a new vehicle every 2 minutes. In the rural regions, such as in Southeastern Ohio, where the concentration of inspectable vehicles per county is significantly lower than in the urbanized regions, rural inspection facilities have been designed. These rural stations would be smaller, require fewer employees, and incorporate larger throughput times, 3 minutes as opposed to 2 for the urban facility. Although highly automated emission inspection and record keeping equipment can be used in the rural stations, there would be two stops rather than three, thus reducing the inspection personnel requirements and helping to minimize the costs. Figure 13 shows the projected network of inspection stations for each county in Ohio.

TABLE 46. INSPECTIONS PERFORMED ANNUALLY, 1982-1987

Year	Inspection Performed
1982	9,396,000
1983	9,593,000
1984	9,793,000
1985	9,988,000
1986	10,207,000
1987	10,420,000
Average	9,901,000

PROGRAM ADMINISTRATION AND PERSONNEL REQUIREMENTS

An administrative network was derived for the proposed I/M programs. The Ohio Environmental Protection Agency would have the primary responsibility for planning, implementation and supervision of the overall program. The Attorney General's Office, Consumer Protection Division would handle consumer complaints concerning the private repair industry; this function is described

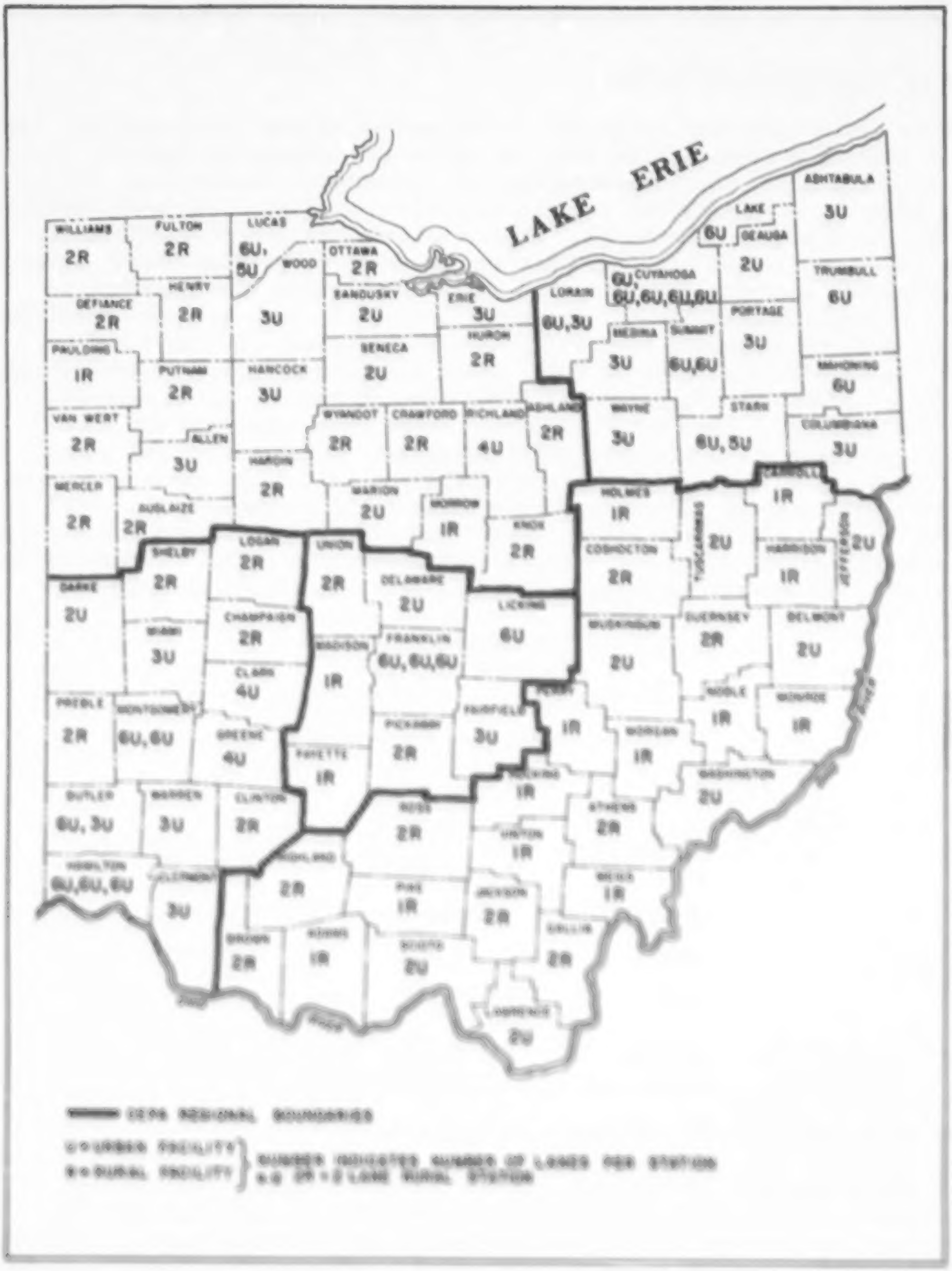

LAKE ERIE
WILLIAMS 2R
FULTON 2R
LUCAS 6U, 5U
WOOD 3U
OTTAWA 2R
SANDUSKY 2U
ERIE 3U
LORAIN 6U,3U
CUYAHOGA 6U, 6U,6U,6U,6U
LAKE 6U
GEAUGA 2U
ASHTABULA 3U
TRUMBULL 6U
DEFIANCE 2R
HENRY 2R
PAULDING 1R
PUTNAM 2R
HANCOCK 3U
SENECA 2U
HURON 2R
MEDINA 3U
SUMMIT 6U,6U
PORTAGE 3U
MAHONING 6U
VAN WERT 2R
ALLEN 3U
WYANDOT 2R
CRAWFORD 2R
RICHLAND 4U
ASHLAND 2R
WAYNE 3U
STARK 6U, 5U
COLUMBIANA 3U
MERCER 2R
AUGLAIZE 2R
HARDIN 2R
MARION 2U
MORROW 1R
KNOX 2R
HOLMES 1R
TUSCARAWAS 2U
CARROLL 1R
HARRISON 1R
JEFFERSON 2U
SHELBY 2R
LOGAN 2R
UNION 2R
DELAWARE 2U
LICKING 6U
COSHOCTON 2R
DARKE 2U
MIAMI 3U
CHAMPAIGN 2R
CLARK 4U
MADISON 1R
FRANKLIN 6U, 6U,6U
MUSKINGUM 2U
GUERNSEY 2R
BELMONT 2U
PREBLE 2R
MONTGOMERY 6U,6U
GREENE 4U
FAYETTE 1R
PICKAWAY 2R
FAIRFIELD 3U
PERRY 1R
MORGAN 1R
NOBLE 1R
MONROE 1R
BUTLER 6U, 3U
WARREN 3U
CLINTON 2R
ROSS 2R
HOCKING 1R
ATHENS 2R
WASHINGTON 2U
HAMILTON 6U,6U, 6U
CLERMONT 3U
HIGHLAND 2R
PIKE 1R
VINTON 1R
JACKSON 2R
MEIGS 1R
BROWN 2R
ADAMS 1R
SCIOTO 2U
GALLIA 2R
LAWRENCE 2U
OEPA REGIONAL BOUNDARIES
U = URBAN FACILITY
R = RURAL FACILITY
NUMBER INDICATES NUMBER OF LANES PER STATION
e.g. 2R = 2 LANE RURAL STATION

Figure 13. Station configurations, I/M network.

in the inspection scenario previously described. The Department of Highway Safety, Bureau of Motor Vehicles deputy registrar system would also be involved because the enforcement procedure is incorporated into the motor vehicle registration process. An organization chart has been included to indicate the actual administrative positions and lines of responsibility, shown in Figure 14. The contractor who actually builds and runs inspection facilities also must have an organizational network for in this large statewide inspection system. This contractor organizational network is shown in Figure 15.

The personnel have been broken down into five separate categories as follows:

1. State of Ohio - Statewide Responsibility. Under this category are those employees of the State of Ohio who exercise stateside control over various aspects of the program include overall administration and supervision as well as specific functional responsibilities.

2. State of Ohio - Regional Responsibility. Under this category are those employees of the State of Ohio who exercise control over a single OEPA region in which they are stationed.

3. Contractor - Statewide Responsibility. Under this category are those employees of the contractor who exercise statewide control over various aspects of the program with the guidance and direction of OEPA. On the state level, the contractor would employ a number of personnel having functions similar to, and coordinating their activities very closely with the state employees in category one.

4. Contractor - Regional Responsibility. Under this category are those contractor employees who exercise responsibility over a program function within a single OEPA region.

5. Contractor - Local Responsibility. Under this category would be all the contractor employees at the inspection station level. The number of employees estimated for the I/M program are shown below in Table 47.

TABLE 47. PROGRAM EMPLOYEES

Personnel category	Number of employees
State - Statewide	12
State - Regional	25
State Total	37
Contractor - Statewide	8
Contractor - Regional	51
Contractor - Local	996
Contractor Total	1,055

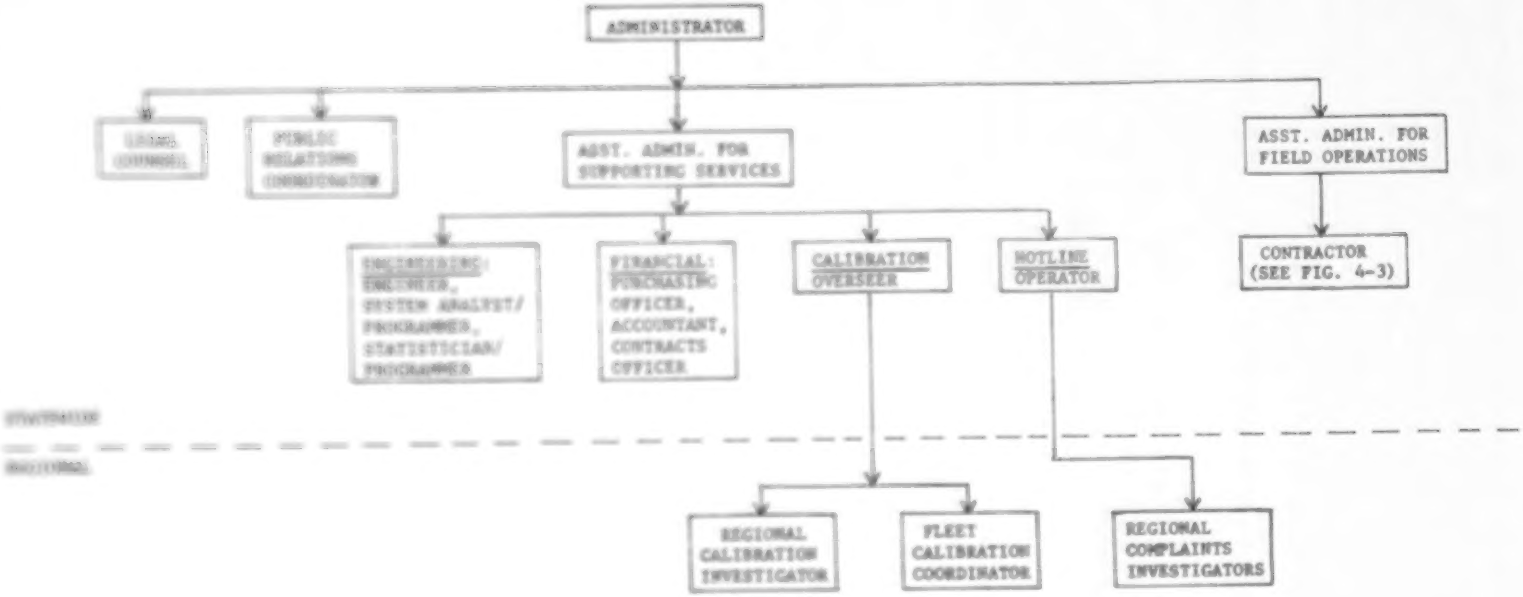

ADMINISTRATOR
LEGAL COUNSEL
PUBLIC RELATIONS COORDINATOR
ASST. ADMIN. FOR SUPPORTING SERVICES
ASST. ADMIN. FOR FIELD OPERATIONS
ENGINEERING: ENGINEER, SYSTEM ANALYST/ PROGRAMMER, STATISTICIAN/ PROGRAMMER
FINANCIAL: PURCHASING OFFICER, ACCOUNTANT, CONTRACTS OFFICER
CALIBRATION OVERSEER
HOTLINE OPERATOR
CONTRACTOR (SEE FIG. 4-3)
STATEWIDE
REGIONAL
REGIONAL CALIBRATION INVESTIGATOR
FLEET CALIBRATION COORDINATOR
REGIONAL COMPLAINTS INVESTIGATORS

Figure 14. State administrative network.

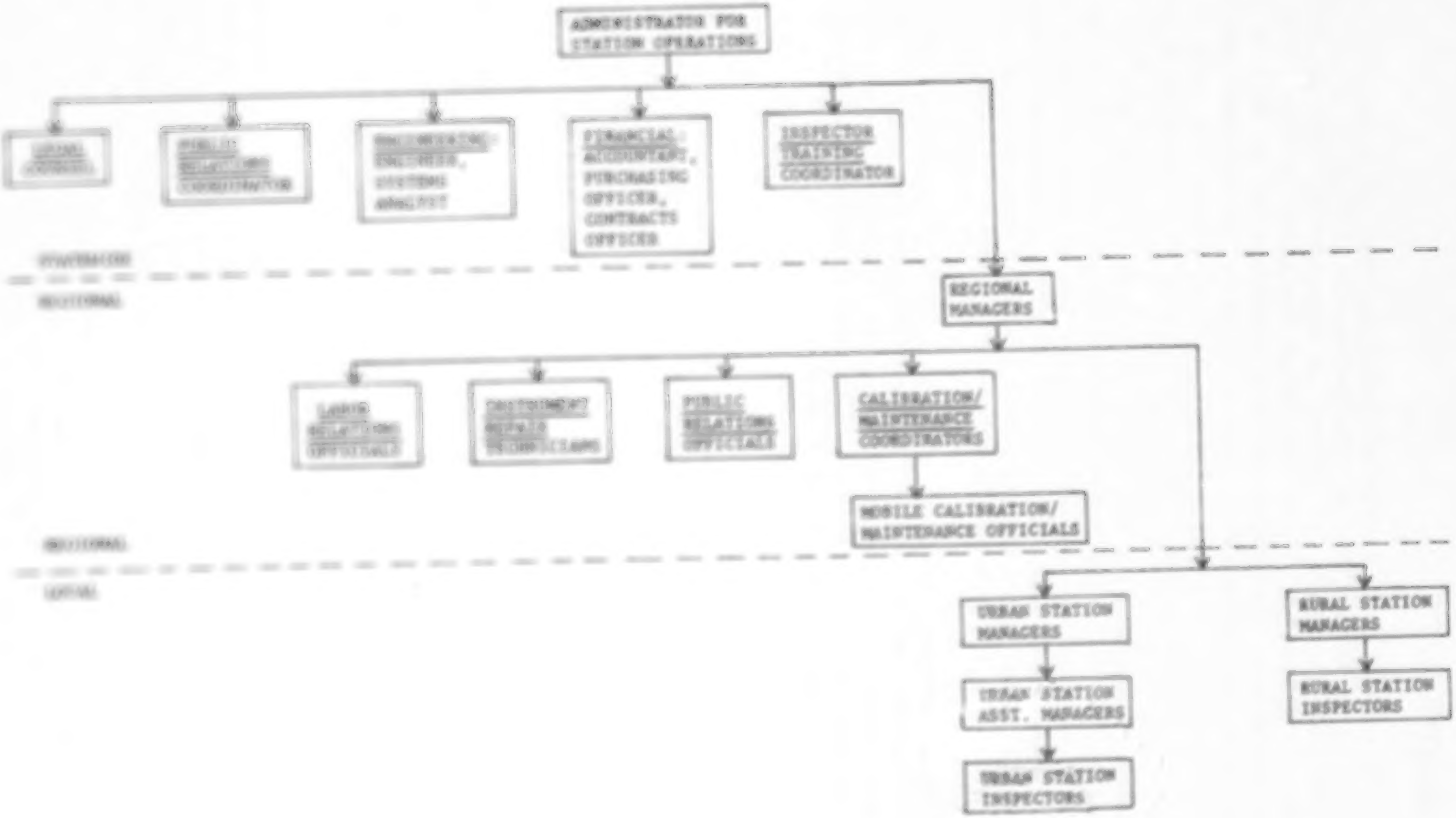

ADMINISTRATOR FOR STATION OPERATIONS
PUBLIC RELATIONS COORDINATOR
ENGINEERING: ENGINEER, SYSTEMS ANALYST
FINANCIAL: ACCOUNTANT, PURCHASING OFFICER, CONTRACTS OFFICER
INSPECTOR TRAINING COORDINATOR
STATEWIDE
REGIONAL
REGIONAL MANAGERS
LABOR RELATIONS OFFICIALS
REPAIR TECHNICIANS
PUBLIC RELATIONS OFFICIALS
CALIBRATION/ MAINTENANCE COORDINATORS
MOBILE CALIBRATION/ MAINTENANCE OFFICIALS
REGIONAL
LOCAL
URBAN STATION MANAGERS
URBAN STATION ASST. MANAGERS
URBAN STATION INSPECTORS
RURAL STATION MANAGERS
RURAL STATION INSPECTORS

Figure 15. Contractor network.

I/M PROGRAM BENEFITS

Concern for controlling automotive emissions stems from the fact that automobile traffic is responsible for approximately 75 percent of all urban carbon monoxide (CO) emissions, 50 percent of hydrocarbons (HC) emissions, and 50 percent of the oxides of nitrogen (NO_x) emissions in Ohio. U.S. EPA indicate that automobile transportation is responsible for as much as 14 to 23 percent of total air pollution costs. A study by the National Academy of Science estimated annual societal costs for this pollution (in 1969) to range from $2.2 to $5.7 billion a year. When these costs are subsequently adjusted to account for today's inflation rates, these costs rise to $3.3 to $8.6 billion a year. Furthermore, a 1978 study by the National Highway Traffic Safety Administration indicates that "the prorated societal cost of air pollution caused by automobiles would be equivalent to from $24.30 to $64.30 per vehicle." This same study also states that "it is conceivable that national inspection and mandatory maintenance would reduce societal cost of pollution $1.3 to $3.4 billion annually."

Besides these economic benefits and the benefit of decreased emissions seen from I/M implementation, other important benefits may accure. These include an improvement in fuel economy, which in turn has a positive effect on gasoline consumption. Benefits have also been indicated for fleets that undergo their own special maintenance programs.

Emissions Reductions

Emissions reduction is the primary benefit to be derived from I/M programs. Although new vehicles are required to meet certain U.S. EPA specifications for emissions, it has been shown that emission rates for in-use vehicles deteriorate significantly unless adequate maintenance is performed. I/M has been suggested as an effective means for ensuring that the necessary routine maintenance is performed periodically, thus resulting in a significant decrease in emissions generated by the motor vehicle population.

The emission reductions ("tail pipe reductions") refer to the decrease in carbon monoxide (CO) and hydrocarbons (HC) from the I/M vehicles. The resulting change in the concentrations of these substances in the ambient atmosphere is not being considered here. These calculations are being made by OEPA and various regional or metropolitan planning organizations as a part of the State Implementation Plan (SIP) that details the overall strategy to reduce air pollution from all sources in Ohio.

Various levels of reductions in emissions have been noted in ongoing I/M programs. The actual reduction varies with stringency factors, climate, and other considerations. Hamilton Test Systems, under contract to the State of Arizona, noted in a 1978 report that of those vehicles undergoing inspection and subsequent maintenance in Arizona I/M program, 25 percent reduction in idle CO emissions and 41 percent reduction in idle HC emissions were shown compared to those tested in 1976 (Pre-I/M). Hamilton Test Systems claim that this program is reducing by about 150 tons daily the amount of CO and HC emitted into the atmosphere in the Arizona counties covered by I/M, as well as saving motorists an estimated 30 million gallons of gasoline annually.

Analyses performed by other state and federal agencies show similar results.

Projected Reduction in Emissions

According to the Federal Guidelines as shown in Appendix F, I/M programs must achieve "at least a 25 percent reduction in light-duty vehicles exhaust emissions of hydrocarbons . . . and carbon monoxide by December 31, 1987, compared to what emissions would be without I/M . . ."

In order to estimate the magnitude of the reduction in emission that results over time from the implementation of an I/M program in Ohio, motor vehicle emission inventories for both CO and HC were developed for the state using U.S. EPA's MOBILE1 computer routine. Input data regarding vehicle miles of travel (VMT) by vehicle type, roadway functional class, and speed were provided by the Ohio Department of Transportation and the Ohio, Kentucky, and Indiana Council of Governments.

Inventories were prepared for each year beginning with 1983 through 1987 for the entire state. Average daily emissions generated by light-duty vehicles (cars and trucks) and by all vehicles were defined for two scenarios. The first scenario reflected the vehicle population emission characteristics in the absence of an I/M program, while the second scenario reflected the compounded effects of an I/M program beginning in January 1982 on emissions during each year. The percent reduction in hydrocarbon and carbon monoxide emissions attributable to the I/M program from 1982 to 1987 is shown in Table 48.

TABLE 48. PROJECTED PERCENT REDUCTIONS IN CO AND HC EMISSIONS 1983 TO 1987 DUE TO I/M*

	1983	1984	1985	1986	1987
Affected Vehicles†					
Carbon monoxide	19	27	33	40	46
Hydrocarbons	6	10	16	22	29
All Vehicles					
Carbon monoxide	14	20	24	29	33
Hydrocarbons	5	8	13	18	24

*Assumes a 20 percent stringency rate. Reductions above the Federal Motor Vehicle Control Program

†LDVs, LDT_1, LDT_2.

The effects on emission reductions of increasing the stringency (failure rate) to 30 and 40 percent were also studied. Increasing the stringency level above 20 percent results in only very slight additional reductions in HC or CO. The reason for this is that at 20 percent failure, nearly all of the gross pollution emitters are failed, whereas the additional cars that fail when the standards are set above this level are less out of adjustment. Repairing these vehicles, then, has only a marginal effect on emission reductions because the worst polluters were already identified and repaired at the 20 percent level.

The reductions shown in Table 47 occur with a stringency level of 20 percent, which means that test standards are set such that 20 percent of the total vehicles tested, on the average, will fail the emissions test and require repairs to bring the vehicle up to standards. U.S. EPA requires that the program produce at least a 25 percent reduction in emissions in 1987 from vehicles included in the program (which are basically the light-duty vehicles, or passenger cars, and the light-duty trucks, or all trucks under 8,500 lb GVW) in comparison to the emissions that would be produced by these same vehicles in 1987 without the program. The figures shown above indicate that the proposed I/M program will, on the average for all counties, achieve a reduction of 46 percent and 29 percent for CO and HC, respectively, indicating that program stringency is more than adequate to meet EPA's minimum standards. Reductions by year are shown graphically for CO and HC in Figures 16 and 17, respectively.

Fuel Economy Benefits

One of the important benefits of I/M programs, in addition to the reduction in vehicular emissions, is potential fuel conservation. A properly tuned engine operates with greater efficiency and therefore, consumes less fuel. This improvement in fuel economy varies somewhat from one program to another but most sources agree that a 5 to 10 percent fuel economy improvement for the failed and maintained vehicles can be expected. This may understate the overall fleet improvement as some motor vehicle owners are likely to schedule tune-ups just prior to having their cars inspected. Those that do not fail are already saving fuel. One of the purposes of I/M is to give an incentive to motorists to maintain their cars better than they normally would in the absence of I/M.

For the purpose of this study, it is assumed that the fuel economy improvement for vehicles that fail the emissions test and therefore undergo maintanence, will be 7 percent averaged over a year. Applying this to the projected statewide vehicle population of 8,251,000 in 1987, the failure rate chosen - 20 percent - and the relative travel distribution by various model year vehicles and EPA requirements for miles per gallon standards for various years, it is estimated that during 1987, approximately 44.6 million gallons of gasoline would be saved as a result of the I/M program. Assuming further that the cost of a gallon of gasoline in 1987 is $0.80, the fuel cost savings associated with the 44.6 million gallons of fuel conserved is $35.7 million. This translates to an average savings of $22 per failed vehicle. Not included in this estimate would be comproble savings for vehicles tuned in anticipation of the emissions test. A detailed discussion concerning the derivation of the fuel savings associated with the program is presented in Section 4, Benefits, and Appendix B of the report.

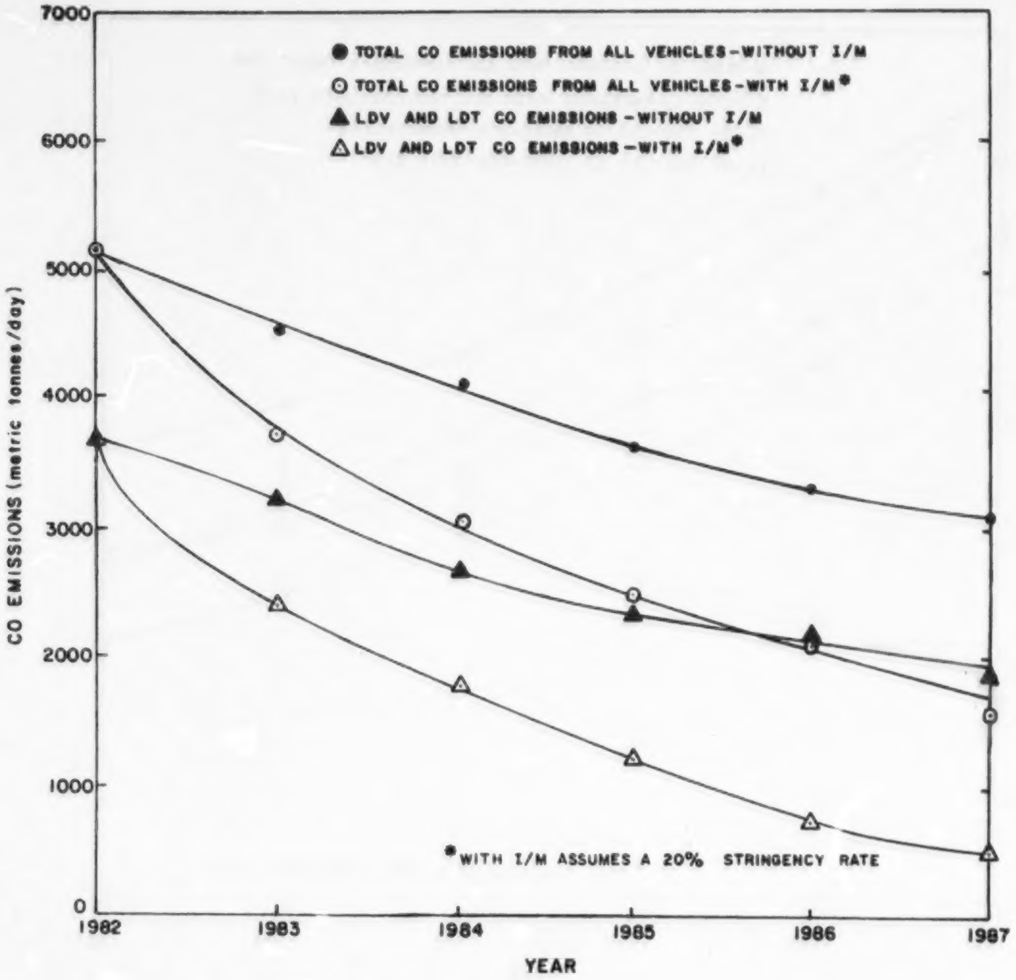


Figure 16. Daily CO emissions by year for LDV's and LDT's only, and for all vehicles with and without I/M — 1982 through 1987.

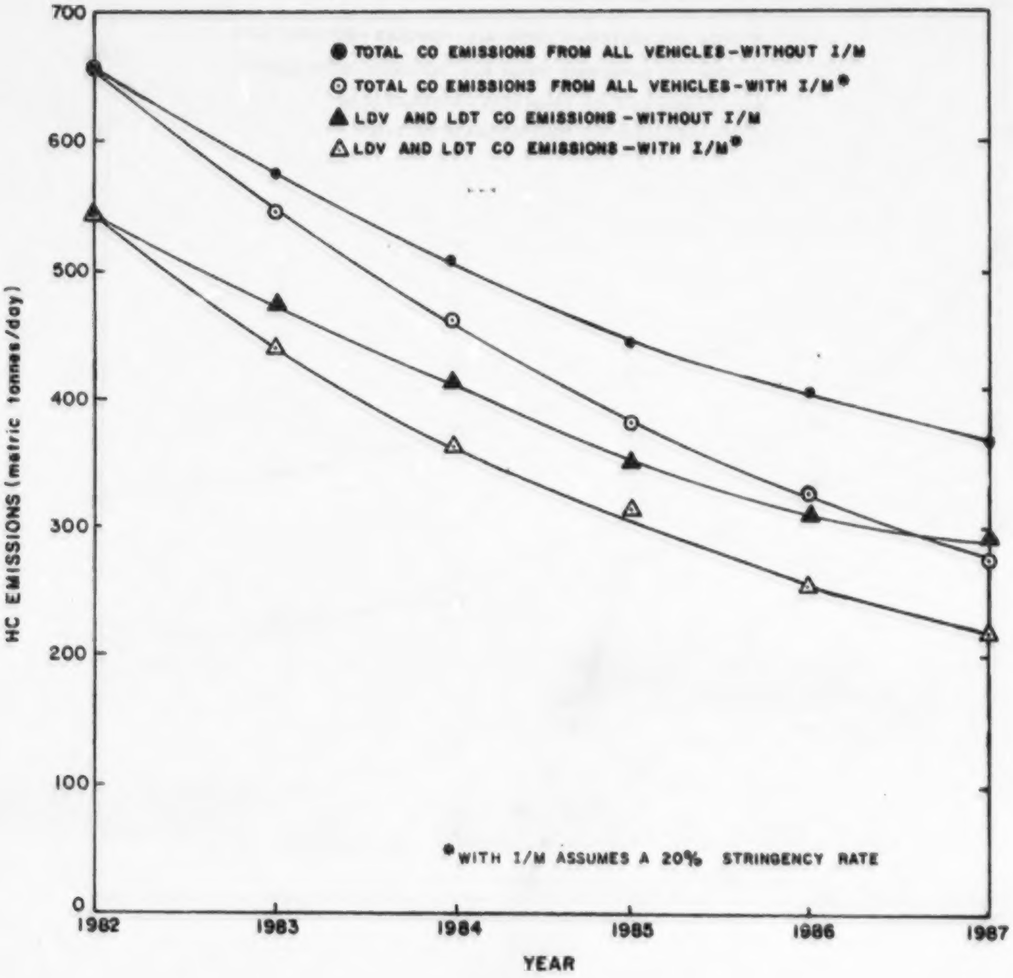


Figure 17. Daily emissions by year for LDV's and LDT's only and for all vehicles with and without I/M - 1982 through 1987.

Impact on Vehicle Performance and Life

The effects of inspection and maintenance programs on vehicle performance and life are currently under study. Preliminary analyses in this area have focused on various vehicle fleets and indicate that I/M does have a positive effect on both vehicle performance and vehicle life, althoug specific, quantitative statistics are not yet available.

Some of the more notable findings to date regarding vehicle performance come from programs established for fleets of vehicles by their owners. One such program may be found in the City of Phoenix, Arizona. In order to reduce on-the-road failures, an extensive preventive maintenance inspection program was implemented for the city's vehicle fleet. Results of the program were closely monitored resulting in the determination that: (1) the fuel consumption rate during the first 6 months of the program decreased approximately 10 percent, much of which was attributed directly to the program; and (2) a significant decrease occurred in the number of vehicles breaking down on the road and requiring towing.

Other Impacts

In addition to the fuel reduction fuel economy, and performance benefits, there are other impacts that result from the I/M program. The implementation of an I/M program in Ohio would result in the creation of approximately 1,055 jobs in the private sector. These would be the employees of the contractor chosen by the state to operate the centralized inspection lanes. They include 996 local, 51 regional, and 8 state level jobs. The majority of the positions would be the actual emission station inspectors. There would be 847 station inspectors at the 57 urban and 45 rural stations. The total annual salaries plus overhead paid for all private contractor employees, are equal to $12.8 million for station level personnel and $0.6 million for contractor regional and state level administrative personnel.

A more detailed breakdown of personnel need is provided in Section 4. The salaries for these positions are paid for by the inspection fee. Other indirect impacts may be on increase in demand for automobile parts and repair station labor for the repair of failed vehicles and those vehicles repaired in anticipation of the emission test that would not have been repaired in its absence. Also, the construction of the test stations themselves would have a temporary economic impact during the 1-year construction period.

I/M PROGRAM COSTS

Program Costs

The development of the specific costs presented in this section relies on an analysis and breakdown of the program elements into specific cost components. These cost components are based on the actual experiences of other states which have implemented I/M programs very similar to the contractor-operated centralized network described in this report. Arizona has an I/M program similar in many ways to the one analyzed here. In addition, a thorough analysis of the program functions and elements was undertaken to make sure that the costs reflect as closely as possible the probable costs that will be experienced when Ohio implements the proposed I/M program. However, it must be realized that while conservative cost assumptions were made whenever feasible, that there may be considerable variation in the individual cost elements fue to fluctuations in markets and in the economy.

Table 49 presents an outline of the various costs, broken down into their component parts. Next, the cost summary in Table 50 gives the basic costs, allocated to the party in charge of that cost element; i.e., either the state, the primary contractor (who builds and runs the inspection lanes), or a secondary contractor who has responsibility only for a limited program function.

Inspection Fee Estimate

An estimate of the inspection fee was calculated in actual dollars; i.e., in dollars that reflect the impact of inflation during the inspection period from 1982 through 1987. This fee was calculated by dividing the total annualized costs by the average annual number of registrations in this period (a free retest was assumed). A 7 percent inflation rate was assumed. The fee is shown below.

Total annualized costs - $44,770,000

Average annual registrations - 8,251,000

Break-even fee estimate - $5.52

This fee does not include a profit for the contractor. The profit would be negotiated between the state and the contractor and would amount to about 10 to 15 of the break even fee shown above. The likely charge to motorists there would be $6.07 to $6.35. The first retest is free.

ADJUNCTIVE PROGRAMS

Several basic support programs were investigated in this study. All of these programs are important in terms of enhancing the overall effectiveness of the program, keeping the public informed, and protecting the consumer from potential abuses or inequities in the system. In brief the programs are as follows:

- quality assurance increases the quality and uniformity of the emission inspection and repair process
- mechanic training increases the quality of the emission repairs
- consumer protection protects the consumer from unneeded repairs or inequities in the testing

TABLE 49. OUTLINE OF PROGRAM COST CATEGORIES AND ELEMENTS

Primary category	Principal element	Items included
I. Initial Capital Costs	1. Building investment	a. Construction cost
	2. Land investment	a. Actual land cost b. Pavement and ;amdscaping
	3. Equipment costs	a. Primary test equipment b. Ancillary equipment c. Office equipment/furniture d. Maintenance equipment
II. One-Time Startup Costs	1. Land acquisition	a. Site location studies b. Title transfer costs
	2. Facilities planning	a. Design study b. Bid efaluation c. Construction monitoring
	3. Program design	a. Develop equipment specifications b. Develop subprograms (e.g., public information, surveillance, quality control, enforcement, etc.) c. Define personnel organizational structure d. Define personnel organizational structure e. Plan program effectiveness studies
	4. Develop data handling systems software	
	5. Personnel training	a. Inspectors b. Managers c. Quality control personnel d. Mechanics training
	6. Personnel salaries and overhead prior to startup	
	7. Initial public information program	
	8. Mechanics training program	
III. Annual Operating Costs	1. Facility personnel	a. Wages, benefits, etc.
	2. Maintenance	a. Equipment
	3. Utilities/services/supplies	a. Electric b. Heat c. Insurance d. Miscellaneous e. Taxes
IV. Annual Administrative Costs	1. Program administrative personnel	a. Wages, overhead
	2. Enforcement	
	3. Consumer protection quality assurance	
	4. Public information	
	5. Training, licensing, certification	

TABLE 50. COST SUMMARY

Primary category - principal element	Cost responsibility ($)			Total element cost ($)	Total category cost ($)
	State	Primary contractor	Secondary contractor		
I. Initial Capital Costs					
1. Building investment		23,450,564		23,450,564	
2. Land investment		6,260,571		6,260,571	
3. Equipment investment		25,379,500		25,579,500	
					55,290,635
II. One-Time Startup Costs					
1. Land acquisition		1,040,533		1,040,533	
2. Facilities planning		3,517,000		3,517,000	
3. Program design	150,000			150,000	
4. Software development		200,000		200,000	
5. Personnel training	1,180	22,869		24,049	
6. Personnel salaries/overhead	534,375	2,884,543	16,250	3,435,168	
7. Public information	50,000	1,138,120		1,188,120	
8. Mechanics training			106,350	106,350	
	735,555	8,803,065	122,600		9.661,220
III. Annual Operating Costs					
1. Personnel		13,070,000		13,070,000	
2. Maintenance		4,558,900		4,588,900	
3. Utilities/services/supplies		5,963,765		5,963,765	
		23,592,665			23,592,665
IV. Annual Administrative Costs					
1. Personnel	534,375	598,125	16,250	1,148,750	
2. Vehicle operation	36,000			36,000	
3. Public information		1,188,120		1,188,120	
4. Personnel training		1,392		1,392	
	570,375	1,781,637	16,250		2,374,262

- public convenience minimizes travel time and waiting at the inspection lanes

- enforcement ensures a maximally effective system to ensure compliance

- public relations provides comprehensive information to the public on the needs, benefits, and procedures of the I/M program

It is important to realize that these adjunctive programs interrelate and overlap to a high degree. Some of the adjunctive program elements may serve multiple purposes. For example, mechanics training serves to increase the quality control of the repair or maintenance phase of the program, serves as an important consumer protection element by encouraging more uniform, less expensive emission tuneups and also may serve as a public relations mechanism by orienting the mechanics to the purpose and benefits of the overall I/M program.

Program Implementation

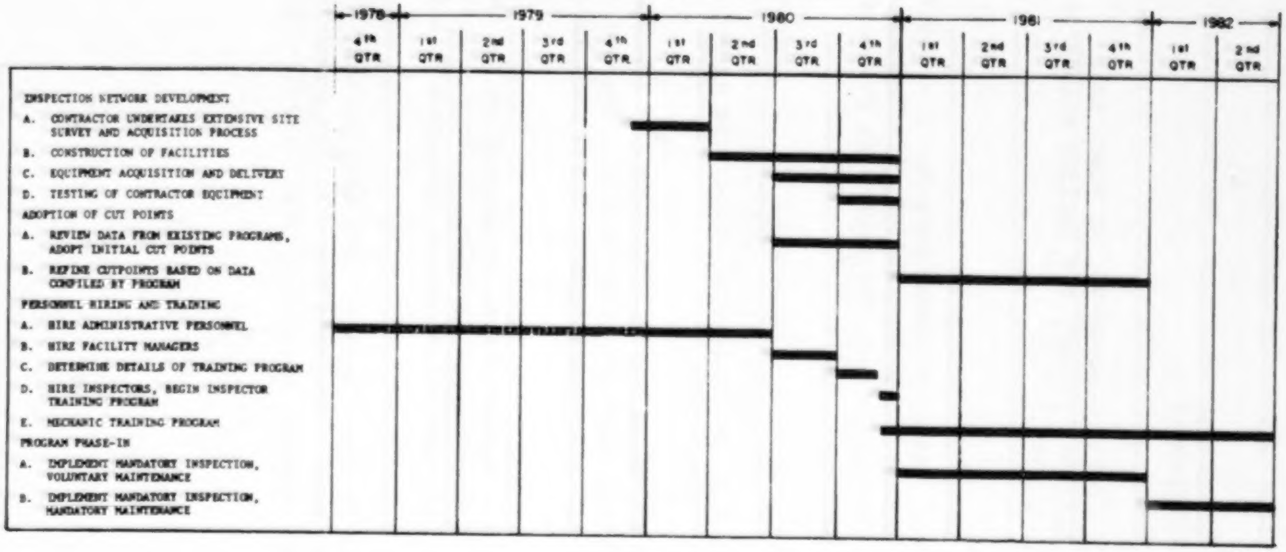
Implementation of Ohio's I/M program will proceed according to the schedule shown in Table 51. This schedule has specifically been designed to meet all applicable Federal requirements while at the same time incorporating policy decisions that have been made by the State of Ohio I/M Advisory Group.

The program cannot be implemented without "adequate legal authority;" that is, legislation specifically creating the program as well as a program budget which must be approved by the state legislature. In order that the recommended schedule be workable, this legislation and budget must be passed in the January to July 1979 legislative session. Once legal authority is secured, several program elements can begin. Initial public relations can be set up, and a detailed Request for Proposal (RFP) can be prepared and distributed to interested private firms. If bids are received by 1 October 1979, a contract can be drawn up and awarded to the preferred bidder by 30 September 1979. During the period December 1978 to March 1980, the contractor would conduct extensive site surveys and acquire property on which to build inspection stations. During the period April to December 1980, all 102 stations in the network would be built, equipped, and tested. Operating personnel would also be hired and trained during this period; managers, assistant managers and investigators 6 months prior to program startup on 1 January 1980, and inspectors 1 month prior to startup. During all of 1980, the inspection program and all adjunctive programs would be operational on a "mandatory inspection-voluntary maintenance basis; this 1-year "trial period" is necessary both to work out any problems in the contractor-operated inspection network and to familiarize the general motoring public with the objectives and methods of the program. Beginning 1 January 1981, the federally-mandated deadline, mandatory inspections and mandatory maintenance would begin.

TABLE 51. OHIO I/M IMPLEMENTATION SCHEDULE

	1978	1979				1980				1981				1982	
	4th QTR.	1st QTR.	2nd QTR.	3rd QTR.	4th QTR.	1st QTR.	2nd QTR.	3rd QTR.	4th QTR.	1st QTR.	2nd QTR.	3rd QTR.	4th QTR.	1st QTR.	2nd QTR.
PRELIMINARY PLANNING															
A. FORMULATE TENTATIVE PLANS FOR THE FORMAT, SCOPE, DESIGN, AND OPERATION OF THE I/M PROGRAM.	■														
B. DEVELOP AN IMPLEMENTATION SCHEDULE THAT WILL ADDRESS ALL EPA SIP REQUIREMENTS	■														
ENABLING LEGISLATION AND DRAFT BUDGET															
A. DEFINE TECHNICAL AND ADMINISTRATIVE ISSUES TO BE ADDRESSED BY ENABLING LEGISLATION	■														
B. PREPARE DRAFT ENABLING LEGISLATION	■														
C. PREPARE PROGRAM BUDGET REQUEST	■														
D. LEGISLATIVE DEBATE AND APPROVAL OF LEGISLATION AND BUDGET		■													
PUBLIC INFORMATION PROGRAM															
A. DEVELOP PROGRAM STRATEGY	■														
B. DEFINE DETAILS OF FIRST STAGE OF THE PUBLIC INFORMATION PROGRAM AND IMPLEMENT	■	■													
C. DEFINE DETAILS OF THE SECOND STAGE OF THE PUBLIC INFORMATION PROGRAM AND IMPLEMENT								■	■	■	■	■	■		
D. DEFINE DETAILS OF THE THIRD STAGE OF THE PUBLIC INFORMATION PROGRAM AND IMPLEMENT														■	■
SELECTION OF CONTRACTOR															
A. PREPARE DETAILED RFP				■											
B. INTERESTED FIRMS PREPARE RESPONSE TO RFP				■											
C. STATE EVALUATES PROPOSALS AND AWARDS CONTRACT					■										

TABLE 51 (continued)



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APPENDIX A

DETAILED DESCRIPTION OF METHODOLOGY FOR CALCULATING EMISSION INVENTORIES

Emission inventories were calculated using USEPA's MOBILE1 computer program. MOBILE1 is an integrated set of FORTRAN routines for use in the analysis of the air pollution impact of mobile sources. MOBILE1 computes emissions utilizing the most recent emission factors and methodology promulgated by the USEPA. These factors and the associated methodology are completely described in MOBILE SOURCE EMISSION FACTORS FOR LOW ALTITUDE AREAS.[1]

The program contains tables of emission levels for each model year vehicle from 1951 to 1990 for vehicle ages between 0 and 20 years old. Emission tables are also class specific; separate tables are used for light-duty vehicles (LDV), light-duty trucks under 6,000 lbs gross vehicle weight (LDT_1), light-duty trucks between 6,000 lbs and 8,000 lbs gross vehicle weight (LDT_2), heavy-duty diesel (HDD), heavy-duty gasoline (HDG), and motorcycles (MC). Separate tables are also given for three geographic region types: California, high altitude, and low altitude. The latter tables are used in Ohio.

Basic emission factors are based in vehicles operating through EPA's Federal Test Procedures (FTP) urban driving cycle, thus, must be adjusted to reflect driving patterns in local areas. MOBILE1 contains correction factors for temperature, speed, hot and cold start, stabilized travel, air-conditioning, vehicle load, and trailer towing, and humidity. Due to lack of data specific to Ohio, default values (FTP-specific conditions) are used for air-conditioning, vehicle load, and trailer towing. Humidity affects nitrogen oxide alone, and thus, is irrelevant for our applications. Hot/cold/stabilized VMT for the 18 urbanized counties were not provided, and thus, national average values of 21 percent/27 percent/52 percent, respectively, were used. Temperature is assumed to be 75°F. This represents the climatological conditions for which the VMT and distribution data are relevant; i.e., a typical July day when effects of emissions are most acute.

The most important correction factor is vehicle speed. Emissions are not linear with respect to speed, so whenever possible speed classes must be differentiated. Speed classes are created by dividing travel between freeways, arterials, and local roads.

For a particular year, say 1987, the above factors give emissions per mile traveled for vehicles of various ages. To get aggregate per mile emissions for 1987, the emission factors for the various aged vehicles are weighted by their travel proportion (e.g., see the last column of Table 52). The data used in calculating travel proportions, the distribution of vehicle ages and the travel

TABLE 52. TRAVEL WEIGHTING FACTOR CALCULATION LIGHT-DUTY VEHICLES

Vehicle age	(a) Fraction total registration	(b) Annual mileage accumulation rate	(a)*(b)	((a)*(b)/sum) Travel fraction
1	0.075	15,900	1,192.5	0.106
2	0.107	15,000	1,605.0	0.142
3	0.107	14,000	1,498.0	0.133
4	0.106	13,100	1,388.6	0.123
5	0.100	12,200	1,220.0	0.108
6	0.092	11,300	1,039.6	0.092
7	0.085	10,300	875.5	0.077
8	0.077	9,400	723.8	0.064
9	0.066	8,500	561.0	0.050
10	0.052	7,600	395.2	0.035
11	0.039	6,700	261.3	0.023
12	0.027	6,600	178.2	0.016
13	0.018	6,200	111.6	0.010
14	0.014	5,900	82.6	0.007
15	0.009	5,500	49.5	0.004
16	0.006	5,100	30.6	0.003
17	0.005	5,000	25.0	0.002
18	0.005	4,700	23.5	0.002
19	0.005	4,400	22.0	0.002
20	0.004	4,400	17.6	0.002
		Sum:	11,301.0	

of vehicles by age, are national averages contained in MOBILE1. An Ohio vehicle age distribution for a particular year is inappropriate since it would reflect low sales in periods of recession and these cyclic fluctuations would be projected into the future periods.

To get aggregate emissions per mile for a particular county or region, values must be combined across the various speed classes (freeways, arterials, local roads). This is achieved by taking weighted averages using vehicle miles traveled (VMT, for the weighting fractions). To calculate total daily emission levels (Tables 8 through 9), emissions per mile are multiplied by VMT. The raw VMT and speed data used in preparing the inventory for the 18 urbanized counties are given in Tables 53 through 55. These data are transformed to the analysis years of 1982 through 1987 by the procedures indicated in Table 56. The data for 1977 and the analysis years are presented in Table 57. Statewide data for 10 highway classifications were provided by ODOT. Derived daily VMT's for 10 statewide highway classifications are provided in Table 58. Derived average speeds and VMT distributions for the 18 counties are presented in Table 59. For the statewide classification, the same distributions plus cold start/hot start are provided in Table 60.

To calculate the effect of an I/M program on emissions, EPA derived - Appendix N,[2] credits (percent reductions) are applied to emission factors. I/M credits are given for carbon monoxide and hydrocarbons, various technologies of vehicles (technology 1 vehicles built prior to 1975, technology 2 vehicles built from 1975 to 1979, technology 3 vehicles built in 1980 and technology 4 vehicles built after 1980) with and without mandatory maintenance, with stringency levels of 10, 20, 30, 40 and 50 percent, and for the number of years I/M has been in effect. In this study, I/M included mandatory maintenance, was at a stringency level of 20 percent, and will be in effect for 5 years (from 1982 to 1987). The effect of increasing the stringency levels beyond 20 percent was also analyzed for 1983 and 1987.

TABLE 53. 1977 O.D.O.T. DATA

County	Daily VMT (000) for 1977			
	Interstate	Major arterial	Minor arterial	Local
Lorain	175.3	1136.8	488.8	155.2
Geauga	-	204.1	530.7	74.5
Greene	185.7	613.3	293.8	24.9
Medina	831.3	491.9	298.9	51.1
Wood	902.4	528.6	465.3	36.5

Source: Ohio Department of Transportation.

TABLE 54. 1975 O.D.O.T. DATA

Yearly growth rates of VMT by highway type:

Interstates	4.7%
Arterials	2.0%
Locals	1.4%

County	Daily VMT (000)	Average speed	LDV	LDT	HDG	HDD
Franklin						
Interstate	4,082	58	76.8	12.0	3.5	7.7
Major arterial	2,012	41	80.5	12.0	3.5	4.0
Minor arterial	960	36	85.0	10.0	3.5	1.5
Local	5,108	36	86.0	10.0	3.0	1.0
Cuyahoga						
Interstate	4,603	55	79.2	12.0	3.5	5.3
Major arterial	3,810	30	81.0	12.0	3.5	3.5
Minor arterial	1,619	25	83.0	12.0	3.5	1.5
Local	9,260	20	86.0	10.0	3.0	1.0
Lake						
Interstate	771	58	70.0	12	3.5	14.5
Major arterial	1,108	50	82.5	12	3.5	2.0
Minor arterial	793	35	86.0	10	3.0	1.0
Local	1,935	35	86.0	10	3.0	1.0
Lucas						
Interstate	1,431	58	74	12	3.5	10.5
Major arterial	1,693	47	79	12	3.5	5.5
Minor arterial	220	40	85	10	3.5	1.5
Local	2,627	40	86	10	3.0	1.0
Mahoning						
Interstate	758	60	67.0	12	3.5	17.5
Major arterial	1,114	52	77	12	3.5	7.5
Minor arterial	393	46	84	10	3.5	2.5
Local	1,640	40	86	10	3.0	1.0
Montgomery						
Interstate	1,962	58	74	12	3.5	10.5
Major arterial	1,582	45	81.5	12	3.5	2.5
Minor arterial	603	45	85.0	10	3.0	2.0
Local	3,532	45	86.0	10	3.0	1.0

(continued)

TABLE 54 (continued).

County	Daily VMT (000)	Average speed	LDV	LDT	HDG	HDD
Stark						
Interstate	527	58	76.5	12.0	3.5	8.0
Major arterial	1,166	48	78	12	3.5	6.5
Minor arterial	633	45	84.0	12.0	3.0	2.0
Local	2,511	40	86.0	10.0	3.0	1.0
Summit						
Interstate	2,292	58	75.5	12	3.5	9.0
Major arterial	1,474	41	79.5	12	3.5	5.0
Minor arterial	713	37	85	10	3.0	2.0
Local	3,359	41	86	10	3.0	1.0
Trumbull						
Interstate	383	58	58.0	12.0	40.	26.0
Major arterial	1,503	49	79.5	12.0	3.5	5.0
Minor arterial	411	45	84.0	10.0	3.5	2.5
Local	1,605	40	86.0	10.0	3.5	0.5

Source: Ohio Department of Transportation, Columbus, Ohio (compiled from local planning data)

TABLE 55. DATA FROM O.K.I.

	Freeway		Arterial		Locals	
	VMT (000)	Average speed	VMT (000)	Average speed	VMT (000)	Average speed
1975						
Hamilton	5,923	40.5	5,707	19.0	560	15.0
Butler	400	53.5	3,555	32.0	168	15.0
Clermont	280	53.5	1,607	34.5	45	15.0
Warren	824	54.0	1,241	34.5	54	15.0
1980						
Hamilton	8,406	41.5	6,587	20.5	627	15.0
Butler	492	54.0	4,081	31.0	177	15.0
Clermont	381	54.5	1,925	34.5	52	15.5
Warren	1,064	54.5	1,610	31.5	60	15.0
1985						
Hamilton	9,981	43.0	7,409	21.0	696	14.5
Butler	660	54.5	4,591	32.5	196	15.0
Clermont	563	56.0	2,261	35.0	58	16.0
Warren	1,485	55.0	2,084	33.0	67	15.0

Source: Ohio, Kentucky, Indiana Council of Governments, Cincinnati, Ohio.

TABLE 56. SOURCE OF VMT, AVERAGE SPEED, AND VEHICLE DATA FOR 1977 AND 1987

County	1977			1987		
	VMT	Average speed	VMT distribution by vehicle type	VMT	Average speed	VMT distribution by vehicle type
Butler	OKI 75-80	OKI 75	ODOT 75A	OKI 80-85	OKI 80-85	ODOT 75A
Cuyahoga	ODOT 75P	ODOT 75	ODOT 75	ODOT 75P	ODOT 75	ODOT 75
Franklin	ODOT 75P	ODOT 75	ODOT 75	ODOT 75P	ODOT 75	ODOT 75
Hamilton	OKI 75-80	OKI 75	ODOT 75A	OKI 80-85	OKI 85	ODOT 75A
Lake	ODOT 75P	ODOT 75	ODOT 75	ODOT 75P	ODOT 75	ODOT 75
Lorain	ODOT 77	ODOT 75A	ODOT 75A	ODOT 77P	ODOT 75A	ODOT 75A
Lucas	ODOT 75P	ODOT 75	ODOT 75	ODOT 75P	ODOT 75	ODOT 75
Mahoning	ODOT 75P	ODOT 75	ODOT 75	ODOT 75P	ODOT 75	ODOT 75
Montgomery	ODOT 75P	ODOT 75	ODOT 75	ODOT 75P	ODOT 75	ODOT 75
Stark	ODOT 75P	ODOT 75	ODOT 75	ODOT 75P	ODOT 75	ODOT 75
Summit	ODOT 75P	ODOT 75	ODOT 75	ODOT 75P	ODOT 75	ODOT 75
Trumbull	ODOT 75P	ODOT 75	ODOT 75	ODOT 75P	ODOT 75	ODOT 75
Clermont	OKI 75-80	OKI 75	ODOT 75A	OKI 80-85	OKI 85	ODOT 75A
Geauga	ODOT 77	ODOT 75A	ODOT 75A	ODOT 77P	ODOT 75A	ODOT 75A
Greene	ODOT 77	ODOT 75A	ODOT 75A	ODOT 77P	ODOT 75A	ODOT 75A
Medina	ODOT 77	ODOT 75A	ODOT 75A	ODOT 77P	ODOT 75A	ODOT 75A
Warren	OKI 75-80	OKI 75	ODOT 75A	OKI 80-85	OKI 85	ODOT 75A
Wood	ODOT 77	ODOT 75A	ODOT 75A	ODOT 77P	ODOT 75A	ODOT 75A

Notes:	ODOT 77	Ohio Department of Transportation - Actual county specific data for 1977 (from Table 53)
	ODOT 75P	Ohio Department of Transportation - Projected county specific data using ODOT growth rates on 1975 ODOT data (from Table 54)
	OKI 75-80	Ohio, Kentucky, Indiana Council of Government - Interpolated county specific data from 1975 and 1980 OKI data (from Table 55)
	OKI 80-85	Ohio, Kentucky, Indiana Council of Government - Projected county specific data using 1980 - 1985 OKI growth rates on 1985 OKI data (from Table 55)
	ODOT 75	Ohio Department of Transportation - Actual county specific data for 1975 (from Table 54)
	ODOT 75A	Ohio Department of Transportation - 9 county averages from 1975 ODOT data (average from Table 54)
	OKI 75	Ohio, Kentucky, Indiana Council of Government - Actual county specific data for 1975 (from Table 55)
	OKI 85	Ohio, Kentucky, Indiana Council of Government - Actual county specific data for 1985 (from Table 55).

TABLE 57. DERIVED DAILY VMT (000) FOR 1977, AND 1982 TO 1987. 18 URBANIZED COUNTIES

	1977	1982	1983	1984	1985	1986	1987
Lorain County							
Interstate	175.3	220.56	230.92	241.77	253.14	265.04	277.50
Major arterial	1,136.8	1,255.12	1,280.22	1,305.83	1,331.94	1,358.58	1,385.75
Minor arterial	488.8	539.68	550.47	561.48	572.71	584.16	595.85
Local	155.2	166.37	168.70	171.06	173.46	175.89	178.35
Geauga County							
Interstate	-	-	-	-	-	-	-
Major arterial	204.1	225.34	229.85	234.45	239.14	243.92	248.80
Minor arterial	530.7	585.94	597.66	609.61	621.80	634.24	646.92
Local	74.5	79.86	80.98	82.12	83.27	84.43	85.61
Greene County							
Interstate	185.7	233.64	244.62	256.12	268.16	280.76	293.95
Major arterial	613.3	677.13	690.68	704.49	718.58	732.95	747.61
Minor arterial	293.8	324.38	330.87	337.48	344.23	351.12	358.14
Local	24.9	26.69	27.07	27.45	27.83	28.22	28.62
Medina County							
Interstate	831.3	1,045.90	1,095.06	1,146.53	1,200.42	1,256.84	1,315.91
Major arterial	491.9	543.10	553.96	565.04	576.34	587.87	599.62
Minor arterial	298.9	330.01	336.61	343.34	350.21	357.21	364.36
Local	51.1	54.78	55.55	56.32	57.11	57.91	58.72
Wood County							
Interstate	902.4	1,135.36	1,188.72	1,244.59	1,303.09	1,364.33	1,428.45
Major arterial	528.6	583.62	595.29	607.20	619.34	631.73	644.36
Minor arterial	465.3	513.73	524.00	534.48	545.17	556.08	567.20
Local	36.5	39.13	39.68	40.23	40.80	41.37	41.95
Franklin County							
Interstate	4,082	5,629.89	5,894.5	6,171.54	6,461.6	6,765.29	7,083.26
Major arterial	2,012	2,311.16	2,357.38	2,404.53	2,452.62	2,501.67	2,551.70
Minor arterial	960	1,102.74	1,124.79	1,147.29	1,170.24	1,193.64	1,217.51
Local	5,108	5,630.11	5,708.93	5,788.85	5,869.90	5,952.08	6,035.41

(continued)

TABLE 57 (continued).

	1975	1982	1983	1984	1985	1986	1987
Cuyahoga County							
Interstate	4,603	6,348.45	6,646.28	6,959.23	7,286.31	7,628.77	7,987.32
Major arterial	3,810	4,376.49	4,464,02	4,553.3	4,644.37	4,737.26	4,832.00
Minor arterial	1,619	1,859.72	1,896.92	1,934.86	1,973.55	2,013.02	2,053.28
Local	9,260	10,206.50	10,349.39	10,494.28	10,641.20	10,790.18	10,941.24
Lake County							
Interstate	771	1,063.36	1,113.34	1,165.67	1,220.45	1,277.82	1,337.87
Major arterial	1,108	1,272.74	1,298.19	1,324.16	1,350.65	1,377.66	1,405.21
Minor arterial	793	910.91	929.13	947.71	966.66	986.00	1,005.72
Local	1,935	2,132.78	2,162.64	2,192.92	2,223.62	2,254.75	2,286.32
Lucas County							
Interstate	1,431	1,973.63	2,066.39	2,163.51	2,265.20	2,371.66	2,483.13
Major arterial	1,693	1,944.73	1,983.62	2,023.29	2,063.76	2,105.03	2,147.13
Minor arterial	220	252.71	257.77	262.92	268.17	273.54	279.01
Local	2,627	2,895.52	2,936.05	2,977.16	3,018.84	3,061.10	3,103.96
Mahoning County							
Interstate	758	1,045.43	1,094.57	1,146.01	1,199.88	1,256.27	1,315.31
Major arterial	1,114	1,279.64	1,305.23	1,331.33	1,357.96	1,385.12	1,412.82
Minor arterial	393	451.43	460.46	469.67	479.07	488.65	498.42
Local	1,640	1,807.63	1,832.94	1,858.60	1,884.62	1,911.00	1,937.76
Montgomery County							
Interstate	1,962	2,705.99	2,833.17	2,966.33	3,105.75	3,251.72	3,404.55
Major arterial	1,582	1,817.22	1,853.57	1,890.64	1,928.45	1,967.02	2,006.36
Minor arterial	603	692.66	706.51	720.64	735.05	749.76	764.75
Local	3,532	3,893.02	3,947.52	4,002.79	4,058.83	4,115.65	4,173.27
Stark County							
Interstate	527	728.84	761.0	796.77	834.21	873.42	914.47
Major arterial	1,166	1,339.37	1,366.16	1,393.48	1,421.35	1,449.78	1,478.77
Minor arterial	633	727.12	741.66	756.49	771.62	787.06	802.80
Local	2,511	2,767.66	2,806.41	2,845.70	2,885.54	2,925.93	2,966.90
Summit County							
Interstate	2,292	3,161.12	3,309.69	3,465.25	3,628.12	3,798.64	3,977.18
Major arterial	1,474	1,693.16	1,727.03	1,761.57	1,796.80	1,832.73	1,869.39
Minor arterial	713	819.01	835.39	852.10	869.14	886.53	904.26
Local	3,359	3,702.34	3,754.17	3,806.73	3,860.02	3,914.06	3,968.86

(continued)

TABLE 57 (continued).

	1975	1982	1983	1984	1985	1986	1987
Trumbull County							
Interstate	383	528.23	553.66	579.05	606.27	634.76	664.60
Major arterial	1,503	1,726.48	1,761.01	1,796.23	1,832.15	1,868.79	1,906.17
Minor arterial	411	472.11	481.55	491.18	501.01	511.03	521.25
Local	1,605	1,769.05	1,793.82	1,818.93	1,844.40	1,870.22	1,896.40
Hamilton County							
Federal	5,923	9,036	9,351	9,666	9,981	10,296	10,611
Aid	5,707	6,915.8	7,080.2	7,244.6	7,409	7,573.4	7,737.8
Local	560	654.6	668.4	682.2	696	709.8	723.6
Butler County							
Federal	400	559.2	592.8	626.4	660	693.6	727.2
Aid	3,555	4,285	4,387	4,489	4,591	4,693	4,795
Local	168	184.6	188.4	192.2	196.00	199.80	203.6
Clermont County							
Federal	280	453.8	490.2	526.6	563.00	599.4	635.8
Aid	1,607	2,059.4	2,126.6	2,193.8	2,261	2,328.2	2,395.4
Local	45	54.4	55.6	56.8	58	59.2	60.4
Warren County							
Federal	824	1,232.4	1,316.6	1,400.8	1,485	1,569.2	1,653.4
Aid	1,241	1,799.6	1,894.4	1,989.2	2,084	2,178.8	2,273.6
Local	54	62.8	64.2	65.6	67.00	68.4	69.8

Notes: Lorain, Geauga, Greene, Medina and Wood projections based on 1977 data and growth rates: Interstates, 4.7 percent; arterials, 2.0 percent; locals, 1.4 percent.

Franklin, Cuyahoga, Lake, Lucas, Mahoning, Montgomery, Stark, Summit and Trumbull projections based on 1975 data and above growth rates.

Hamilton, Butler, Clermont and Warren interpolated from 1980 and 1985 projections.

TABLE 58. OHIO STATEWIDE DAILY VMT's (000) FOR 1977, AND 1982 TO 1987

Classification	1977	1982	1983	1984	1985	1986	1987
Federal-Aid Interstate Rural (Arterial)*	20,593	25,909	27,127	28,402	29,737	31,135	32,598
Federal-Aid Interstate Urban (Arterial)*	32,863	41,347	43,290	45,325	47,455	49,686	52,021
Federal-Aid Other Primary Rural (Arterial)†	27,227	30,060	30,662	31,275	31,900	32,538	33,189
Federal-Aid Other Primary Urban (Arterial)†	21,758	24,022	24,503	24,993	25,493	26,003	26,523
Federal-Aid Urban (Arterial)†	22,590	24,941	25,440	25,949	26,468	26,999	27,537
Federal-Aid Urban (Collector)†	14,220	15,701	16,015	16,335	16,662	16,995	17,335
Federal-Aid Secondary Rural (Collector)†	19,904	21,975	22,415	22,863	23,320	23,787	24,263
Non-Federal-Aid Rural (Collector)†	8,258	9,117	9,300	9,486	9,675	9,869	10,066
Non-Federal-Aid Rural (Local)‡	31,438	33,701	34,173	34,651	35,136	35,628	36,127
Non-Federal-Aid Urban (Local)‡	18,497	19,828	20,106	20,388	20,673	20,962	21,256

*Growth rate = 4.7 percent per annum.

†Growth rate = 2.0 percent per annum.

‡Growth rate = 1.4 percent per annum.

Note: Based on 1977 annual VMT provided in Table TA-1 by ODOT. These figures adjusted into daily VMT by dividing by standard factor of 322.

TABLE 59. DERIVED AVERAGE SPEED AND VMT DISTRIBUTIONS FOR 1977 AND 1987

County	1977 Average speed	1987 Average speed	LDV	LDT_1	LDT_2	HDG	HDD
Butler							
Interstate	53.5	54.5	0.723	0.072	0.048	0.035	0.122
Arterial	32.0	32.5	0.822	0.066	0.044	0.034	0.034
Local	15.0	15.0	0.860	0.060	0.040	0.030	0.010
Cuyahoga							
Interstate	55.0	55.0	0.792	0.072	0.048	0.035	0.053
Major arterial	30.0	30.0	0.81	0.072	0.048	0.035	0.035
Minor arterial	25.0	25.0	0.83	0.072	0.048	0.035	0.015
Local	20.0	20.0	0.86	0.06	0.04	0.03	0.01
Franklin							
Interstate	58.0	58.0	0.768	0.072	0.048	0.035	0.077
Major arterial	41.0	41.0	0.805	0.072	0.048	0.035	0.04
Minor arterial	36.0	36.0	0.85	0.06	0.04	0.035	0.015
Local	36.0	36.0	0.86	0.06	0.04	0.03	0.01
Hamilton							
Interstate	40.5	43.0	0.723	0.072	0.048	0.035	0.122
Arterial	19.0	21.0	0.822	0.066	0.044	0.034	0.034
Local	15.0	14.5	0.860	0.060	0.040	0.030	0.010
Lake							
Interstate	58.0	58.0	0.7	0.072	0.048	0.035	0.145
Major arterial	50.0	50.0	0.825	0.072	0.048	0.035	0.02
Minor arterial	35.0	35.0	0.86	0.06	0.04	0.03	0.01
Local	35.0	35.0	0.86	0.06	0.04	0.03	0.01
Lorain							
Interstate	58.0	58.0	0.723	0.072	0.048	0.035	0.122
Major arterial	44.8	44.8	0.798	0.072	0.048	0.035	0.047
Minor arterial	39.0	39.0	0.846	0.060	0.04	0.033	0.021
Local	37.4	37.4	0.860	0.060	0.04	0.030	0.010
Lucas							
Interstate	58.0	58.0	0.74	0.072	0.048	0.035	0.105
Major arterial	47.0	47.0	0.79	0.072	0.048	0.035	0.055
Minor arterial	40.0	40.0	0.85	0.06	0.04	0.035	0.015
Local	40.0	40.0	0.86	0.06	0.04	0.03	0.01
Mahoning							
Interstate	60.0	60.0	0.67	0.072	0.048	0.035	0.175
Major arterial	52.0	52.0	0.77	0.072	0.048	0.035	0.075
Minor arterial	46.0	46.0	0.84	0.06	0.04	0.035	0.025
Local	40.0	40.0	0.86	0.06	0.04	0.03	0.01

(continued)

TABLE 59 (continued)

County	1977 Average speed	1987 Average speed	LDV	LDT_1	LDT_2	HDG	HDD
Montgomery							
Interstate	58.0	58.0	0.74	0.072	0.048	0.035	0.105
Major arterial	45.0	45.0	0.815	0.072	0.048	0.035	0.025
Minor arterial	45.0	45.0	0.85	0.06	0.04	0.03	0.02
Local	45.0	45.0	0.86	0.06	0.04	0.03	0.01
Stark							
Interstate	58.0	58.0	0.765	0.072	0.048	0.035	0.08
Major arterial	48.0	48.0	0.78	0.072	0.048	0.035	0.065
Minor arterial	45.0	45.0	0.84	0.072	0.048	0.03	0.02
Local	40.0	40.0	0.86	0.06	0.04	0.03	0.01
Summit							
Interstate	58.0	58.0	0.755	0.072	0.048	0.035	0.09
Major arterial	41.0	41.0	0.795	0.072	0.048	0.035	0.05
Minor arterial	37.0	37.0	0.85	0.06	0.04	0.03	0.02
Local	41.0	41.0	0.86	0.06	0.04	0.03	0.01
Trumbull							
Interstate	58.0	58.0	0.58	0.072	0.048	0.4	0.26
Major arterial	49.0	49.0	0.795	0.072	0.048	0.035	0.05
Minor arterial	45.0	45.0	0.84	0.06	0.04	0.035	0.025
Local	40.0	40.0	0.86	0.06	0.04	0.035	0.005
Clermont							
Interstate	53.5	56.0	0.723	0.072	0.048	0.035	0.122
Arterial	34.5	35.0	0.822	0.066	0.044	0.034	0.034
Local	15.0	16.0	0.860	0.06	0.04	0.03	0.01
Geauga							
Interstate	58.0	58.0	0.723	0.072	0.048	0.035	0.122
Major arterial	44.8	44.8	0.798	0.072	0.048	0.035	0.047
Minor arterial	39.0	39.0	0.846	0.060	0.040	0.033	0.021
Local	37.4	37.4	0.860	0.060	0.040	0.030	0.010
Greene							
Interstate	58.0	58.0	0.723	0.072	0.048	0.035	0.122
Major arterial	44.8	44.8	0.798	0.072	0.048	0.035	0.047
Minor arterial	39.0	39.0	0.846	0.060	0.040	0.033	0.021
Local	37.4	37.4	0.860	0.060	0.040	0.030	0.010
Medina							
Interstate	58.0	58.0	0.723	0.072	0.048	0.035	0.122
Major arterial	44.8	44.8	0.798	0.072	0.048	0.035	0.041
Minor arterial	39.0	39.0	0.846	0.060	0.040	0.033	0.021
Local	37.4	37.4	0.860	0.060	0.040	0.030	0.010
Warren							
Interstate	54.0	55.0	0.723	0.072	0.048	0.035	0.122
Arterial	34.5	33.0	0.822	0.066	0.044	0.034	0.034
Local	15.0	15.0	0.860	0.060	0.040	0.030	0.010
Wood							
Interstate	58.0	58.0	0.723	0.072	0.048	0.035	0.122
Major arterial	44.8	44.8	0.798	0.072	0.048	0.035	0.047
Minor arterial	39.0	39.0	0.846	0.060	0.040	0.033	0.021
Local	37.4	37.0	0.860	0.060	0.040	0.030	0.010

Notes: See Table 56 for data sources.

LDT_1 is taken as 0.6 of LDT and LDT_2 is taken as 0.4 of LDT.

TABLE 60. DERIVED AVERAGE SPEED, VMT DISTRIBUTION, AND COLD/HOT START PERCENTAGES FOR STATEWIDE INVENTORY

Highway classification	Average speed (mph)	Cold starts (%)	Hot starts (%)	LDV	LDT_1	LDT_2	HDG	HDD	MC
Federal-Aid Interstate, Rural	54.0	10	15	0.795	0.015	0.015	0.040	0.130	0.005
Federal-Aid Interstate, Urban	55.0	4	5	0.795	0.015	0.015	0.040	0.130	0.005
Federal-Aid Other Primary, Rural	45.0	10	10	0.785	0.040	0.040	0.030	0.100	0.005
Federal-Aid Other Primary, Urban	53.0	5	10	0.785	0.040	0.040	0.030	0.100	0.005
Federal-Aid Urban Arterial	29.0	20	15	0.795	0.075	0.075	0.020	0.030	0.005
Federal-Aid Urban Collector	52.0	10	10	0.785	0.040	0.040	0.030	0.100	0.005
Federal-Aid Secondary Rural Collector	40.0	20	15	0.795	0.075	0.075	0.020	0.030	0.005
Non-Federal-Aid Rural Collector	25.0	15	20	0.795	0.075	0.075	0.020	0.030	0.005
Non-Federal-Aid Rural Local	25.0	15	20	0.795	0.075	0.075	0.020	0.030	0.005
Non-Federal-Aid Urban Local	40.0	20	15	0.795	0.075	0.075	0.020	0.030	0.005

REFERENCES

1. U.S. Environmental Protection Agency. Mobile Source Emission Factors For Low-Altitude Areas. Final Document. EPA-400/9-78-006. March 1978.

2. U.S. Environmental Protection Agency. Appendix N - Emission Reduction Achievable Through Inspection and Maintenance of Light-Duty Vehicles, Motorcycles and Light- and Heavy-Duty Trucks. Proposed Rule. Federal Register 24(84):22177-22183. May 2, 1977.

APPENDIX B

ESTIMATED FUEL SAVING IN 1987 RESULTING FROM I/M

Fuel savings resulting from the implementation of I/M in Ohio are calculated by determining program impact on the fuel consumption of LDTs and LDVs under 13 years old. Four factors are critical in deriving these figures. They are: (1) the stringency rate established, (2) average fleet fuel consumption rate (for LDV, LDT1 and LDT2) measured in miles per gallon, (3) total vehicle miles traveled (VMT), and (4) actual fuel economy improvement resulting from I/M.

The program will cover LDVs, LDT1s and LDT2s. Since vehicles in each of these categories exhibit different fuel consumption patterns, fuel savings are estimated separately for each of them.

The forumala used to calculate fuel savings is:

$$\text{Gallons saved per year} = \frac{(\text{VMT})(\text{W})}{(\text{FM})} \times \text{S} \times \text{F} \times 322$$

where: VMT = daily vehicle miles traveled by the pertinent vehicle type in selected counties in 1987

W = weighting factor to determine how many VMT are generated by vehicles covered by the I/M program

FM = average fleet mileage for a fleet of a certain vehicle type in 1987

S = stringency rate

F = improvement in fuel economy realized by failed vehicles undergoing required maintenance

322 = factor to adjust daily VMT by yearly VMT

Table 61 presents VMT estimates for LDVs, LDT1s and LDT2s in 1987. LDVs will generate 222,560,000 VMT daily, and LDT1 and LDT2 each will generate 13,295,058 daily VMT.

TABLE 61. ESTIMATED DAILY LDV, LDT1 AND LDT2 VMT FIGURES FOR OHIO FOR 1987 BY ROAD CLASSIFICATIONS

Road classification[a]	VMT IN 1987		
	LDV	LDT1	LDT2
Federal-Aid Interstate Rural (arterial)[b]	25915526[e]	489118[g]	489118[g]
Federal-Aid Interstate Urban (arterial)[b]	41356714[e]	780206[g]	780206[g]
Federal-Aid Other Primary Rural (arterial)[c]	26053342[f]	1327606[h]	1327606[h]
Federal-Aid Other Primary Urban (arterial)[c]	20820520[f]	1060990[h]	1060990[h]
Federal-Aid Urban (arterial)[c]	21891814[e]	2065308[i]	2065308[i]
Federal-Aid Urban (collector)[c]	13608042[f]	693266[h]	693266[h]
Federal-Aid Secondary Rural (collector)[c]	19289088[e]	1819622[i]	1819622[i]
Nonfederal-Aid Rural (collector)[c]	8002344[e]	755090[i]	755090[i]
Nonfederal-Aid Rural (local)[d]	28721112[e]	2709630[i]	2709630[i]
Nonfederal-Aid Urban (local)[d]	16898560[e]	1594222[i]	1594222[i]
Total	222560000	13295058	13295058

[a] Based on 1977 VMT figures as broken down in Table TA-1, U.S. DOT, June 5, 1978

[b] VMT growth assumed to be 4.7% per annum

[c] VMT growth assumed to be 2.0% per annum

[d] VMT growth assumed to be 1.4% per annum

[e] LDV VMT calculated as 79.5% of VMT

[f] LDV VMT calculated as 78.5% of VMT

[g] LDT1 and LDT2 each calculated as 1.5% of VMT

[h] LDT1 and LDT2 each calculated as 4.0% of VMT

[i] LDT1 and LDT2 each calculated as 7.5% of VMT

FUEL SAVINGS

LDV Fuel Savings

The LDV VMT figure reported in Table 61 must be adjusted to reflect VMT generated LDVs less than 14 years old. Table 62 calculates travel weighting factors for LDVs by model year. These fractions are summed up in Table 63 resulting in a travel weighting factor, W - 0.968.

TABLE 62. TRAVEL WEIGHTING FACTOR CALCULATION FOR LIGHT-DUTY VEHICLES

Year	Vehicle age	(a) Fraction total registration	(b) Annual mileage accumulation rate	(a) * (b)	[(a) * (b)/sum] travel fraction
1987	1	0.075	15900	1192.5	0.106
1986	2	0.107	15000	1605.0	0.142
1985	3	0.107	14000	1498.0	0.133
1984	4	0.106	13100	1388.6	0.123
1983	5	0.100	12200	1220.0	0.108
1982	6	0.092	11300	1039.6	0.092
1981	7	0.085	10300	875.5	0.077
1980	8	0.077	9400	723.8	0.064
1979	9	0.066	8500	561.0	0.050
1978	10	0.052	7600	395.2	0.035
1977	11	0.039	6700	261.3	0.023
1976	12	0.027	6600	178.2	0.015
Pre-1976	13+	0.066	5490	362.4	0.032

SOURCE: Mobile I, EPA; January 1978.

TABLE 63. EPA MPG SPECIFICATIONS AND AVERAGE FLEET MILEAGE FOR LDVs COVERED BY I/M IN 1987

Year	EPA mileage standard	Travel fraction*	$\frac{\text{Column (2)} \times \text{column (3)}}{0.968}$
1987	27.5	0.106	3.011
1986	27.5	0.142	4.034
1985	27.5	0.133	3.778
1984	27	0.123	3.431
1983	26	0.108	2.901
1982	24	0.092	2.281
1981	22	0.077	1.750
1980	20	0.064	1.322
1979	19	0.050	0.981
1978	18	0.035	0.651
1977	17.5	0.023	0.416
1976	16.8	0.015	0.260
Totals		0.968	24.817

*From Table 62.

SOURCE: Federal Register, Book 1, Vol. 42, No. 126, p.33534, Thursday, June 30, 1977.

Table 64 presents potential fuel savings based on a total 1987 daily LDV VMT figure of 222,560,000, a weighting factor of 0.968 and a fleet mileage rate of 24.817 mpg. A range of stringency rates is presented to illustrate the sensitivity of fuel savings to this policy variable. A wide range of potential improvement in fuel economy realized by failed vehicles is presented since data on this factor is inconclusive to date.

TABLE 64. POTENTIAL ANNUAL LDV FUEL SAVINGS IN 1987 DUE TO I/M (IN GALLONS)

Increase in fuel economy realized by failed vehicles (%)	Stringency level (%)			
	10	20	30	40
2	5590564	11181128	16771692	22362256
3	8385846	16771692	25157538	33543384
4	11181128	22362256	33543384	44724512
5	13976410	27952820	41929230	55905640
6	16771692	33543384	50315076	67086768
7	19566974	29133948	58700922	78267896
8	22362256	44724512	67086768	98449024
9	25157538	50315076	75472614	100630000
10	27952820	55905640	83858460	111810000

LDT1 Fuel Savings

LDT1 generated VMT in 1987 are reported in Table 61. They generate 13,295,058 daily VMT. Table 65 calculates travel weighting factors which are summed up in Table 66 resulting in W = 0.906. Applying the travel weighting factors to estimated mile per gallon by model year figures results in an LDT1 fleet mileage figure of 21.36 mpg. Table 67 presents estimated fuel savings for LDT1 for a variety of stringency levels and potential improvements in fuel economy.

LDT2 Fuel Savings

LDT2 generated VMT in 1987 are reported in Table 61. They generate 13,295,058 daily VMT. Table 68 calculates travel weighting factors which are summed in Table 69 resulting in W = 0.8851. Applying the travel weighting factors to estimated mile per gallon by model year figures results in an LDT2 fleet mileage figure of 17.81 mpg. Table 70 presents estimated fuel savings for LDT2 for a variety of stringency levels and potential improvements in fuel economy.

TABLE 65. TRAVEL WEIGHTING FACTOR CALCULATION LIGHT-DUTY GAS TRUCKS<6000 LBS (LDT 1)

Year	Vehicle age	(a) Fraction total registration	(b) Annual mileage accumulation rate	(a) * (b)	(a) * (b)/sum Travel fraction
1987	1	0.061	15900	969.9	0.0927
1986	2	0.095	15000	1425.0	0.1362
1985	3	0.094	14000	1316.0	0.1258
1984	4	0.103	13100	1349.3	0.1290
1983	5	0.083	12200	1012.6	0.0968
1982	6	0.076	11300	858.8	0.0821
1981	7	0.076	10300	782.8	0.0748
1980	8	0.063	9400	592.2	0.0566
1979	9	0.054	8500	459.0	0.0439
1978	10	0.043	7600	326.8	0.0312
1977	11	0.036	6700	241.2	0.0231
1976	12	0.024	6600	158.4	0.0152
Pre-1976	13+	0.184	5273	970.0	0.094
			Sum =	10,462.0	

SOURCE: Mobile I, EPA, January 1978.

TABLE 66. MILEAGE ESTIMATES AND AVERAGE FLEET MILEAGE FOR LDT1 COVERED BY I/M IN 1987

Year	Estimated mileage[*]	Travel fraction[†]	$\frac{\text{Column (2)} \times \text{column (3)}}{0.906}$
1987	24.50	0.0927	2.507
1986	24.50	0.1362	3.683
1985	24.50	0.1258	3.402
1984	23.56	0.129	3.355
1983	22.22	0.097	2.379
1982	20.07	0.0821	1.819
1981	18.00	0.0748	1.486
1980	16.00	0.0566	1.000
1979	14.85	0.0439	0.720
1978	13.74	0.0312	0.473
1977	13.04	0.0231	0.332
1976	12.22	0.0152	0.205
Total		0.906	21.360

[*] Based on limited LDT1 mileage figures. More complete data may be available in the future.

[†] From Table 65.

TABLE 67. POTENTIAL ANNUAL LDT1 FUEL SAVINGS IN 1987 DUE TO I/M (IN GALLONS)

Increase in fuel savings realized by failed vehicles (%)	Stringency level (%)			
	10	20	30	40
2	363216	726432	1089648	1452864
3	544824	1089648	1634472	2179296
4	726432	1452864	2179296	2905728
5	908040	1816080	2724120	3632160
6	1089648	2179296	3268944	4358592
7	1270934	2541868	3812802	5083736
8	1452542	2905084	4357626	5810168
9	1634150	3268300	4902450	6536600
10	1815758	3631516	5447274	7263032

SUMMARY FIGURES

Table 71 presents combined fuel savings for all LDVs and LDTs covered by a statewide I/M program in 1987. As a best guess single estimate, 2,541,868 gallons will be saved in 1987 if the stringency rate is 20 percent and failed vehicles undergoing repairs experience a 7 percent improvement in fuel economy.

If fuel prices increase at 2 percent per year (a conservative estimate) and the current average price is \$0.67 per gallon, a gallon of fuel will cost \$0.80 in 1987. Thus, I/M can potentially save consumers \$35.7 million in fuel costs in 1987 alone.* If 8,251,000 vehicles are covered by the program 1,650,200 will fail. These vehicles will realize the fuel economy improvement and hence receive the monetary savings resulting from lower fuel consumption rates. The average failed vehicle will save 27 gallons of fuel or \$21.60 in 1987.

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*This assumes a 20 percent stringency rate and a 7 percent fuel savings.

TABLE 68. TRAVEL WEIGHTING FACTOR CALCULATION LIGHT-DUTY GAS TRUCKS 6001 TO 8500 LB (LDT2)

Year	Vehicle age	(a) Fraction total registration	(b) Annual mileage accumulation rate	(a)*(b)	((a)*(b)/sum) travel fraction
1987	1	0.037	15,700	580.9	0.0614
1986	2	0.070	15,700	1099.0	0.1162
1985	3	0.078	14,100	1099.8	0.1162
1984	4	0.086	12,600	1083.6	0.1145
1983	5	0.075	11,300	847.5	0.0896
1982	6	0.075	10,200	765.0	0.0809
1981	7	0.075	9,400	705.0	0.0745
1980	8	0.068	8,600	584.8	0.0618
1979	9	0.059	8,000	472.0	0.0499
1978	10	0.053	7,500	397.5	0.0420
1977	11	0.044	7,100	312.4	0.0330
1976	12	0.032	6,600	211.2	0.0223
	13+	0.248	5,255	1303.0	0.138
				Sum = 9,461.7	

SOURCE: Mobile I, EPA, January 1978.

TABLE 69. MILEAGE ESTIMATES AND AVERAGE FLEET MILEAGE FOR LDT2s COVERED BY I/M IN 1987

Year	Estimated mileage*	Travel fraction†	Column (2) × column (3) / 0.8851
1987	21.750	0.0614	1.509
1986	21.750	0.1162	2.855
1985	21.750	0.1162	2.855
1984	20.864	0.1145	2.699
1983	19.618	0.0896	1.986
1982	17.673	0.0809	1.615
1981	15.808	0.0745	1.331
1980	14.000	0.0618	0.978
1979	12.955	0.0499	0.730
1978	11.945	0.0420	0.567
1977	11.295	0.0330	0.421
1976	10.538	0.0223	0.266
		0.8851	17.812

*Based on limited LDT2 mileage figures. More complete data may become available in the future.

†From Table 68.

TABLE 70. POTENTIAL ANNUAL LDT2 FUEL SAVING IN 1987 DUE TO I/M (IN GALLONS)

Increase in fuel economy realized by failed vehicles (%)	Stringency level (%)			
	10	20	30	40
2	425362	850724	1276086	1701448
3	638204	1276408	1914612	2552816
4	851046	1702092	2553138	3404184
5	1063888	2127776	3191664	4255552
6	1276408	2552816	3829224	5105632
7	1489250	2978500	4467750	5957000
8	1702092	3404184	5106276	6808368
9	1914612	3829224	5743836	7658448
10	2127454	4254908	6382362	8509816

TABLE 71. POTENTIAL ANNUAL FUEL SAVINGS DUE TO I/M IN 1987 (IN GALLONS)

Increase in fuel economy realized by failed vehicles (%)	Stringency rate (%)			
	10	20	30	40
2	6379142	12758284	19137426	25516568
3	9568874	19137748	28706622	38275496
4	12758606	25517212	38275818	51034424
5	15948338	31896676	47845014	63793352
6	19137748	38275496	57413244	76550992
7	22327158	44654316	66981474	89308632
8	25516890	51033780	76550670	102070000
9	28706300	57412600	86118900	114830000
10	31896032	63792064	95688096	127580000

APPENDIX C

FEDERAL GUIDELINES ON INSPECTION/MAINTENANCE

Listed below are some of the major guidelines the United States Environmental Protection Agency has issued to all states for designing air Inspection/Maintenance program:

Geographic coverage: The Costle Memorandum of February 24, 1978 states that SIP's must provide for implementation of Inspection/Maintenance in "major urban areas" which "are those with an urbanized population of 200,000 or greater." This is the minimum allowed by United States Environmental Protection Agency. The Hawkins Policy Memorandum of July 17, 1978 states that "statewide programs are encouraged."

Inspection frequency: United States Environmental Protection Agency says an Inspection/Maintenance program must require inspection at least on an annual basis.

Implementation deadline: The Hawkins memo states that legislation must be passed no later than June 30, 1979, giving legal authority to begin Inspection/Maintenance, and that a fully mandatory program must start by December 31, 1981.

Emissions reductions required: Stringency factors are to be set to achieve "at least a 25 percent reduction in light duty vehicle exhaust emissions of hydrocarbons...and carbon monoxide by December 31, 1987, compared to what emissions would be without I/M..."

Other program requirements: In addition to the above requirements, the Hawkins memo states that all I/M programs must:

"1. provide for regular periodic inspections of all vehicles for which emission reductions are claimed (random roadside checks, while a useful addition to an I/M program, are not an acceptable substitute for regular inspections);

2. provide for maintenance and retesting of failed vehicles to provide for compliance with applicable emission standards;

3. prohibit registration or provide some equally effective mechanism to prevent vehicles which do not comply with the applicable exhaust emission requirements from operating on public roads;

4. provide for quality control regulations and procedures for the inspection system including:

   a. minimum specifications for emission analyzers

   b. required calibrations of all types on analyzers and

   c. minimum record keeping;

5. provide for either a mechanis' training program or a program to inform the public of service establishments with approved emission analyzers; and

6. inform the public of the reason for the I/M program plus the locations and hours of inspection stations."

APPENDIX D

TAX RATES AND ANNUAL TAXES

The contractor would be required to pay taxes on centralized facilities. Specifically, the land, buildings and equipment are subject to taxation. Tax rates for each municipality were obtained from 1976 Actual Tax Rates on Real Property for Current Expenses and Debt in Ohio Cities, Table PR-5 No. 2 (1978), published by Ohio Department of Taxation, Research and Statistics Section. Rates used in calculation were effective rates computed by the Research and Statistics Section. Taxable property consists of land, buildings including all facility furnishings, and equipment (assumed assessed at full value). Tax rates, taxable property, and annual taxes itemized by county and municipality are shown in Table 72. The "additional equipment" category includes vans, cars and the central computer, all assumed registered or based in Columbus.

TABLE 72. TAX RATES FOR OHIO MUNICIPALITIES

County	Municipality	Total property value ($)	Tax rate	Annual tax ($)	
Adams	West Union	207,260	0.04796	9,940	
Allen	Lima	530,587	0.04010	21,276	
Ashland	Ashland	297,901	0.04130	12,303	
Ashtabula	Ashtabula	530,587	0.04624	24,534	
Athens	Athens	297,901	0.04530	13,495	
Anglaize	Wapakoneta	297,901	0.03675	10,948	
Belmont	St. Clairsville	393,413	0.04796	18,868	
Brown	Georgetown	297,901	0.04796	14,287	
Butler	Hamilton	976,365	0.03837	37,463	
	Middletown	530,587	0.03416	18,125	55,588
Carroll	Carrollton	207,260	0.04796	9,940	
Champaign	Urbana	297,901	0.03960	11,797	
Clark	Springfield	666,942	0.05020	33,480	
Clermont	Batavia	530,587	0.04796	25,447	
Clinton	Wilmington	297,901	0.03716	11,070	
Columbiana	Lisbon	530,587	0.04796	25,447	
Coshocton	Coshocton	297,901	0.04610	13,733	
Crawford	Bucyrus	297,901	0.03103	9,244	
Cuyahoga	Cleveland	976,365	0.06493	63,395	
	Euclid	976,365	0.05342	52,157	
	Lakewood	976,365	0.04796	46,826	
	Parma	976,365	0.04495	43,888	
	Garfield Heights	976,365	0.05035	49,160	255,426
Darke	Greenville	393,413	0.03410	4,072	
Defiance	Defiance	297,901	0.03508	13,801	
Delaware	Delaware	393,413	0.03240	12,747	
Erie	Sandusky	530,587	0.04023	21,346	
Fairfield	Lancaster	530,587	0.04560	24,195	
Fayette	Washington Court House	207,260	0.03265	6,767	
Franklin	Columbus	976,365	0.04040	39,445	
	Whitehall	976,365	0.03610	35,247	
	Upper Arlington	976,365	0.04570	44,620	119,312
Fulton	Wauseon	297,901	0.04796	14,287	
Gallia	Gallipolis	297,901	0.03510	10,456	
Geauga	Chardon	393,413	0.04796	18,868	
Greene	Xenia	666,942	0.05040	33,614	
Guernsey	Cambridge	297,901	0.03385	10,083	

(continued)

TABLE 72 (continued)

County	Municipality	Total property value ($)	Tax rate	Annual tax ($)	
Hamilton	Cincinnati	976,365	0.05044	49,248	
	Reading	976,365	0.04552	44,444	
	Norwood	976,365	0.05022	49,033	142,725
Hancock	Findlay	530,587	0.04400	23,346	
Hardin	Kenton	297,901	0.04020	11,976	
Harrison	Cadiz	207,260	0.04796	9,940	
Henry	Napoleon	297,901	0.03224	9,604	
Highland	Hillsboro	297,901	0.02443	7,278	
Hocking	Logan	207,260	0.03520	7,296	
Holmes	Millersburg	207,260	0.04796	9,940	
Huron	Norwalk	297,901	0.03562	10,611	
Jackson	Jackson	297,901	0.03140	9,354	
Jefferson	Steubenville	393,413	0.03810	14,989	
Knox	Mt. Vernon	297,901	0.03580	10,665	
Lake	Painesville	976,365	0.04778	46,651	
Lawrence	Ironton	393,413	0.04260	16,759	
Licking	Newark	976,365	0.03940	34,469	
Logan	Bellefontaine	297,901	0.04525	13,480	
Lorain	Elyria	976,365	0.04113	40,158	
	Lorain	530,587	0.04215	22,364	
Lucas	Toledo	976,365	0.03609	35,237	
	Maumee	825,086	0.03453	28,490	63,727
Madison	London	207,260	0.04796	9,940	
Mahoning	Youngstown	976,365	0.04820	47,060	
Marion	Marion	393,413	0.04560	17,940	
Medina	Medina	530,587	0.05720	30,350	
Meigs	Pomeroy	207,260	0.04796	9,940	
Mercer	Celina	297,901	0.02800	8,341	
Miami	Troy	530,587	0.04710	24,990	
Monroe	Woodsfield	207,260	0.04796	9,940	
Montgomery	Dayton	976,365	0.05744	56,082	
	Kettering	976,365	0.05018	48,994	105,076
Morgan	McConnellsville	207,260	0.04796	9,940	
Morrow	Mt. Gilead	207,260	0.04796	9,940	
Muskingum	Zanesville	393,413	0.02954	11,621	

(continued)

TABLE 72 (continued)

County	Municipality	Total property value ($)	Tax rate	Annual tax ($)	
Noble	Caldwell	207,260	0.04796	9,940	
Ottawa	Port Clinton	297,901	0.03547	10,567	
Paulding	Paulding	207,260	0.04796	9,940	
Perry	New Lexington	207,260	0.04796	9,940	
Pickaway	Circleville	297,901	0.03080	9,175	
Pike	Waverly	207,260	0.03840	7,959	
Portage	Kent	530,587	0.05741	30,461	
Preble	Eaton	297,901	0.03836	11,427	
Putnam	Ottawa	297,901	0.04796	14,287	
Richland	Mansfield	666,942	0.04113	27,431	
Ross	Chillicothe	393,413	0.04860	19,120	
Sandusky	Fremont	393,413	0.03752	14,761	
Sciota	Portsmouth	393,413	0.04040	15,894	
Seneca	Tiffin	393,413	0.03340	13,140	
Shelby	Sidney	297,901	0.03770	11,231	
Stark	Canton Alliance	976,365 825,086	0.03840 0.04160	37,492 34,324	71,816
Summit	Akron Cuyahoga Falls	976,365 976,365	0.04985 0.06180	48,672 60,340	109,012
Trumbull	Warren	976,365	0.04520	44,132	
Tuscarawas	New Philadelphia	393,413	0.04041	15,898	
Union	Marysville	297,901	0.03820	11,380	
Van Wert	Van Wert	297,901	0.04600	13,703	
Vinton	McArthur	207,260	0.04796	9,940	
Warren	Lebanon	530,587	0.03435	18,226	
Washington	Marietta	393,413	0.03429	13,490	
Wayne	Wooster	530,587	0.04040	21,436	
Williams	Bryan	297,901	0.03243	9,661	
Wood	Bowling Green	530,587	0.03360	17,828	
Wyandot	Upper Sandusky	297,901	0.04190	12,482	
Facilities Total				2,251,058	
Additional Equipment	Columbus	1,498,000	0.04040	60,519	
Total				2,311,577	

APPENDIX E

PROJECTED EMISSION REDUCTIONS FOR 18 SELECTED OHIO COUNTIES

Motor vehicle emission inventories for both CO and HC were developed for lw nonattainment counties listed below:

- Butler
- Cuyahoga
- Franklin
- Hamilton
- Lake
- Lorain
- Lucas
- Mahoning
- Montgomery
- Stark
- Summit
- Trumbull

and the six adjacent counties:

- Clermont
- Geauga
- Green
- Medina
- Warren
- Wood

Inventories were prepared using U.S. EPA's MOBILE 1 computer program, an integrated set of FORTRAN subroutines for use in the analysis of the air pollution impact of mobile sources. A detailed description of the methodology used in deriving these inventories is presented in Appendix A.

Inventories were prepared for each year beginning with 1982 through 1987 for the 18 counties. Average daily emissions generated by light-duty vehicles (LDVs, LDT1's and LDT2's) and by all vehicles were defined for two scenarios. The first scenario reflected the vehicle population omission trends in the absence of an I/M program, while the second scenario reflected the compounded effects of an I/M program beginning in January 1982 on emissions during each year.

Comparison of the emission totals for both the total vehicle population and for affected vehicles indicate the impact that I/M can be expected to have. Tables 73 and 74 provide a summary by county of daily CO emissions for affected vehicles and for all vehicles respectively. These CO reductions are displayed graphically in Figure 18. Tables 75 and 76 present a summary by county of daily HC emissions for affected vehicles and for all vehicles respectively. These HC reductions are presented graphically in Figure 19.

Of particular interest are the reductions achievable by 1987 for affected vehicles (LDV, LDT1, LDT2) for both CO and HC. U.S. EPA requires that the program produce at least a 25 percent reduction in emissions from affected vehicles compared to emissions that would be produced by these same vehicles in 1987 without I/M. As can be seen from Tables 73 and 74, the proposed I/M program will produce, on average, reductions of 45 percent and 31 percent for CO and HC respectively. This indicates that the proposed I/M program is more than adequate to meet U.S. EPA's minimum standards.

TABLE 73. PROJECTED CO EMISSIONS (kg/day) AND PERCENT REDUCTIONS ACHIEVABLE FOR LDV's AND LDT's ONLY, IN 18 URBANIZED COUNTIES

County	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Butler	122,284	111,258	91,209	18	101,323	74,823	26	92,810	62,674	32	85,479	51,876	39	79,503	43,470	45
Cuyahoga	677,619	612,967	501,980	18	555,299	409,533	26	506,604	341,390	33	464,563	281,557	39	430,835	235,314	45
Franklin	281,024	255,573	209,662	18	232,843	172,009	26	213,706	144,259	32	197,100	119,546	39	183,862	100,357	45
Hamilton	443,718	404,563	331,788	18	369,033	272,833	26	338,588	228,933	32	311,903	189,923	39	290,339	159,584	45
Lake	109,114	98,839	80,999	18	89,695	66,160	26	81,971	55,224	33	75,263	45,534	40	69,867	38,019	46
Loraine	41,625	37,785	30,987	18	34,353	25,368	26	31,439	21,212	33	28,902	17,523	39	26,854	14,651	45
Lucas	126,089	114,829	94,322	18	104,701	77,526	26	96,098	65,086	32	88,558	53,969	39	82,489	45,322	45
Mahoning	79,487	73,010	59,868	18	66,353	48,968	26	60,727	40,935	33	55,835	33,788	39	51,913	28,239	46
Montgomery	162,843	148,170	121,454	18	134,990	99,591	26	123,837	83,449	33	114,128	69,051	39	106,325	57,839	46
Stark	106,552	96,465	79,050	18	87,472	64,523	26	79,889	53,818	33	73,260	44,315	40	67,961	36,961	46
Summit	172,613	156,960	128,755	18	142,987	105,612	26	131,193	88,636	32	120,957	73,333	39	112,754	61,505	45
Trumbull	83,566	75,771	62,099	18	68,754	50,718	26	62,808	42,321	33	57,637	34,875	39	53,446	29,088	46
Clermont	56,081	51,695	42,399	18	47,612	35,176	26	44,092	29,769	32	40,975	24,876	39	38,471	21,038	45
Geauga	18,120	16,391	13,427	18	14,833	10,933	26	13,526	9,102	33	12,390	7,481	40	11,495	6,239	46
Green	23,401	21,307	17,480	18	19,380	14,318	26	17,802	12,021	32	16,396	9,950	39	15,278	8,346	45
Medina	33,154	30,427	24,994	18	27,048	19,503	28	26,720	18,71	30	24,005	14,619	39	22,549	12,373	45
Warren	65,836	61,740	50,642	18	57,850	42,749	26	54,390	36,741	32	51,242	31,131	39	48,728	26,675	45
Wood	38,657	35,427	29,095	18	32,501	24,051	26	30,040	20,330	32	27,882	16,968	39	26,159	14,340	45
Total 18 counties	2,641,783	2,403,177	1,970,190	18	2,187,027	1,614,394	26	2,006,260	1,354,617	32	1,846,475	1,120,315	39	1,718,828	939,360	45

TABLE 74. PROJECTED CO EMISSIONS (kg/day) AND PERCENT REDUCTIONS ACHIEVABLE FOR ALL VEHICLES,* IN 18 URBANIZED COUNTIES

County	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Butler	155,938	144,865	124,617	14	133,136	106,637	20	122,936	92,741	25	113,739	80,135	30	106,488	70,457	34
Cuyahoga	844,340	776,244	665,238	14	708,979	563,214	21	650,232	485,019	25	598,158	415,155	31	559,255	361,734	35
Franklin	368,311	342,369	296,460	13	315,629	254,794	19	292,107	222,659	24	270,938	193,384	29	254,557	171,055	33
Hamilton	576,602	536,112	463,338	14	494,547	398,348	19	457,570	347,915	24	424,212	302,234	29	397,992	267,238	33
Lake	140,033	129,466	111,625	14	118,794	95,260	20	109,416	82,669	24	101,012	71,286	29	94,428	62,580	34
Loraine	54,436	50,491	43,691	13	46,435	37,451	19	42,843	32,617	24	39,611	28,232	29	37,077	24,876	33
Lucas	171,870	160,294	139,786	13	148,125	120,948	18	137,316	106,305	23	127,504	92,915	27	119,858	82,691	31
Mahoning	106,910	99,157	86,013	13	91,205	73,821	19	84,190	64,399	24	77,859	55,815	28	72,923	49,249	32
Montgomery	213,908	198,931	172,215	13	183,372	147,972	19	169,634	129,248	24	157,240	112,163	29	147,575	99,088	33
Stark	136,548	126,135	108,731	14	115,606	92,656	20	106,361	80,290	25	98,018	69,069	30	91,510	60,512	34
Summit	246,810	210,871	182,665	13	194,435	157,061	19	179,950	137,295	24	166,923	119,298	29	156,787	105,538	33
Trumbull	143,695	135,768	122,075	10	126,038	108,003	14	117,083	96,597	17	108,765	86,008	21	102,384	78,026	24
Clermont	72,574	68,327	59,029	14	63,673	51,235	20	59,464	45,143	24	55,595	39,496	29	52,594	35,162	33
Geauga	23,073	21,298	18,334	14	19,474	15,573	20	17,883	13,457	25	16,454	11,547	30	15,359	10,102	34
Green	31,021	29,579	25,056	15	26,594	21,532	19	24,643	18,860	23	22,839	16,393	28	21,451	14,518	32
Medina	46,085	43,360	37,927	13	39,253	31,709	19	38,853	30,853	21	35,347	25,959	27	33,518	23,342	30
Warren	86,688	83,058	71,957	13	78,750	63,647	19	74,686	57,036	24	70,814	50,703	28	67,870	45,815	32
Wood	53,415	50,176	43,845	13	46,681	38,231	18	43,958	33,887	23	40,781	29,867	27	38,624	26,806	31
Total 18 counties	3,452,257	3,206,281	2,772,602	14	2,950,726	2,378,092	19	2,729,125	2,076,990	24	2,522,809	1,799,659	29	2,368,250	1,588,789	33

*I/M program applies to LDV's and LDT's only.

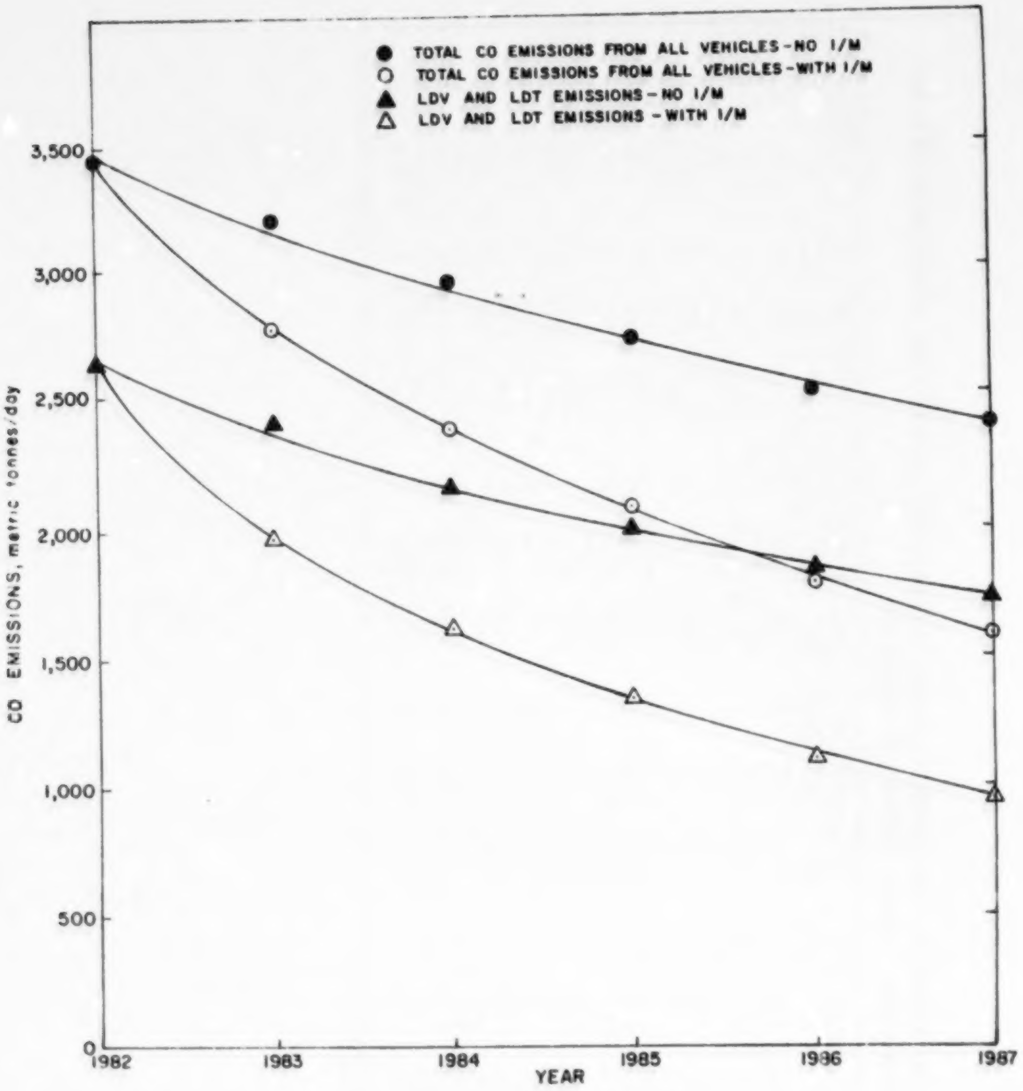

Figure 18. Ohio 18 urbanized counties daily CO emissions by year for LDV's and LDT's, and all vehicles with and without I/M - 1982 to 1987.

TABLE 75. PROJECTED HC* EMISSIONS (kg/day) AND PERCENT REDUCTIONS ACHIEVABLE FOR LDV's AND LDT's ONLY, IN 18 URBANIZED COUNTIES

County	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Butler	13,606	12,028	11,253	06	10,692	9,496	11	9,607	7,923	18	8,728	6,551	25	8,070	5,496	32
Cuyahoga	70,623	62,411	58,134	07	55,522	48,946	12	48,975	40,750	18	45,526	33,639	26	42,226	28,198	33
Franklin	34,291	30,135	28,300	06	26,623	23,885	10	23,763	19,918	16	21,461	16,476	23	19,752	13,845	30
Hamilton	47,114	41,883	39,070	07	37,437	33,096	12	33,815	27,701	18	30,882	22,974	26	28,690	19,335	33
Lake	12,970	11,355	10,671	06	10,001	8,950	11	8,904	7,430	17	8,017	6,116	24	7,357	5,112	31
Loraine	5,050	4,420	4,160	06	3,890	3,488	10	3,456	2,899	16	3,108	2,388	23	2,848	1,996	30
Lucas	15,582	13,671	12,883	06	12,067	10,843	10	10,726	9,036	16	9,656	7,471	23	8,855	6,272	29
Mahoning	10,063	8,798	8,292	06	7,730	6,956	10	6,861	5,774	16	6,160	4,893	21	5,639	3,978	29
Montgomery	20,286	17,772	16,755	06	15,662	14,079	10	13,907	11,712	16	12,509	9,667	23	11,469	8,103	29
Stark	12,974	11,325	10,660	06	9,939	8,922	10	8,818	7,392	16	7,908	6,072	23	7,235	5,069	30
Summit	21,336	18,718	17,593	06	16,506	14,836	10	14,703	12,355	16	13,254	10,210	23	12,178	8,568	30
Trumbull	10,169	8,884	8,383	06	7,798	6,998	10	6,911	5,799	16	6,200	4,767	23	5,669	3,977	30
Clermont	6,472	5,782	5,424	06	5,184	4,622	11	4,688	3,894	17	4,287	3,250	24	3,988	2,749	30
Geauga	2,158	1,885	1,773	06	1,655	1,480	11	1,470	1,226	17	1,317	1,004	24	1,209	836	31
Green	2,862	2,511	2,364	06	2,209	1,986	10	1,971	1,654	16	1,772	1,365	23	1,628	1,143	30
Medina	4,193	3,702	3,493	06	3,158	2,795	11	3,066	2,652	14	2,664	2,070	22	2,458	1,749	29
Warren	7,597	6,898	6,472	06	6,284	5,608	11	5,766	4,794	17	5,339	4,056	24	5,029	3,477	31
Wood	4,866	4,295	4,052	06	3,807	3,430	10	3,409	2,876	16	3,085	2,395	22	2,847	2,023	29
Total 18 counties	302,210	266,473	249,772	06	236,120	210,410	11	211,816	175,783	17	191,873	145,361	24	177,147	121,926	31

*Nonmethane HC only.

TABLE 76. PROJECTED HC* EMISSIONS (kg/day) AND PERCENT REDUCTIONS ACHIEVABLE FOR ALL VEHICLES, IN 18 URBANIZED COUNTIES

County	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent Reduction
Butler	16,083	14,307	13,531	5%	12,753	11,555	9%	11,465	9,780	15%	10,420	8,243	21%	9,638	7,062	27%
Cuyahoga	83,018	73,767	69,489	6%	65,773	59,197	10%	59,218	49,992	16%	53,996	42,068	22%	50,051	36,022	28%
Franklin	39,801	35,139	33,363	5%	31,082	28,345	9%	27,713	23,867	14%	24,987	20,006	20%	22,955	17,046	26%
Hamilton	58,310	52,308	49,496	5%	46,972	42,629	9%	42,520	36,408	14%	38,910	31,006	20%	36,233	26,877	26%
Lake	14,964	13,165	12,478	5%	11,612	10,558	9%	10,326	8,851	14%	9,288	7,386	20%	8,510	6,267	26%
Loraine	5,891	5,181	4,920	5%	4,565	4,164	9%	4,053	3,494	14%	3,693	2,918	21%	3,328	2,476	26%
Lucas	18,791	16,596	15,810	5%	14,667	13,459	8%	13,054	11,363	13%	11,744	9,560	19%	10,762	8,177	24%
Mahoning	11,796	10,363	9,859	5%	9,119	8,343	9%	8,083	6,998	13%	7,244	5,840	19%	6,616	4,956	25%
Montgomery	23,409	20,595	19,578	5%	18,143	16,579	9%	16,108	13,912	14%	14,462	11,620	20%	13,228	9,860	25%
Stark	14,840	13,002	12,337	5%	11,421	10,400	9%	10,114	8,689	14%	9,055	7,217	20%	8,261	6,096	26%
Summit	24,779	21,846	20,758	5%	19,293	17,620	9%	17,170	14,820	14%	15,455	12,412	20%	14,170	10,563	25%
Trumbull	13,403	11,793	11,274	4%	10,362	9,565	8%	9,149	8,035	12%	8,162	6,701	18%	7,407	5,716	23%
Clermont	7,647	6,875	6,516	5%	6,180	5,618	9%	5,593	4,796	14%	5,112	4,074	20%	4,755	3,517	26%
Geauga	2,476	2,172	2,059	5%	1,909	1,734	9%	1,693	1,447	15%	1,517	1,202	21%	1,388	1,016	27%
Green	3,368	2,971	2,824	5%	2,618	2,393	9%	2,332	2,015	14%	2,097	1,689	19%	1,923	1,439	25%
Medina	5,073	4,513	4,303	5%	3,863	3,502	9%	3,743	3,328	11%	3,253	2,658	18%	3,001	2,292	24%
Warren	9,120	8,338	7,912	5%	7,616	6,941	9%	6,990	6,020	14%	6,474	5,189	20%	6,096	4,544	25%
Wood	5,869	5,216	4,972	5%	4,634	4,257	8%	4,149	3,618	13%	3,753	3,063	18%	3,461	2,636	24%
Total	358,638	318,147	301,479	5%	282,582	256,859	9%	253,473	217,433	14%	229,622	182,852	20%	211,783	156,562	26%

*Nonmethane HC only.

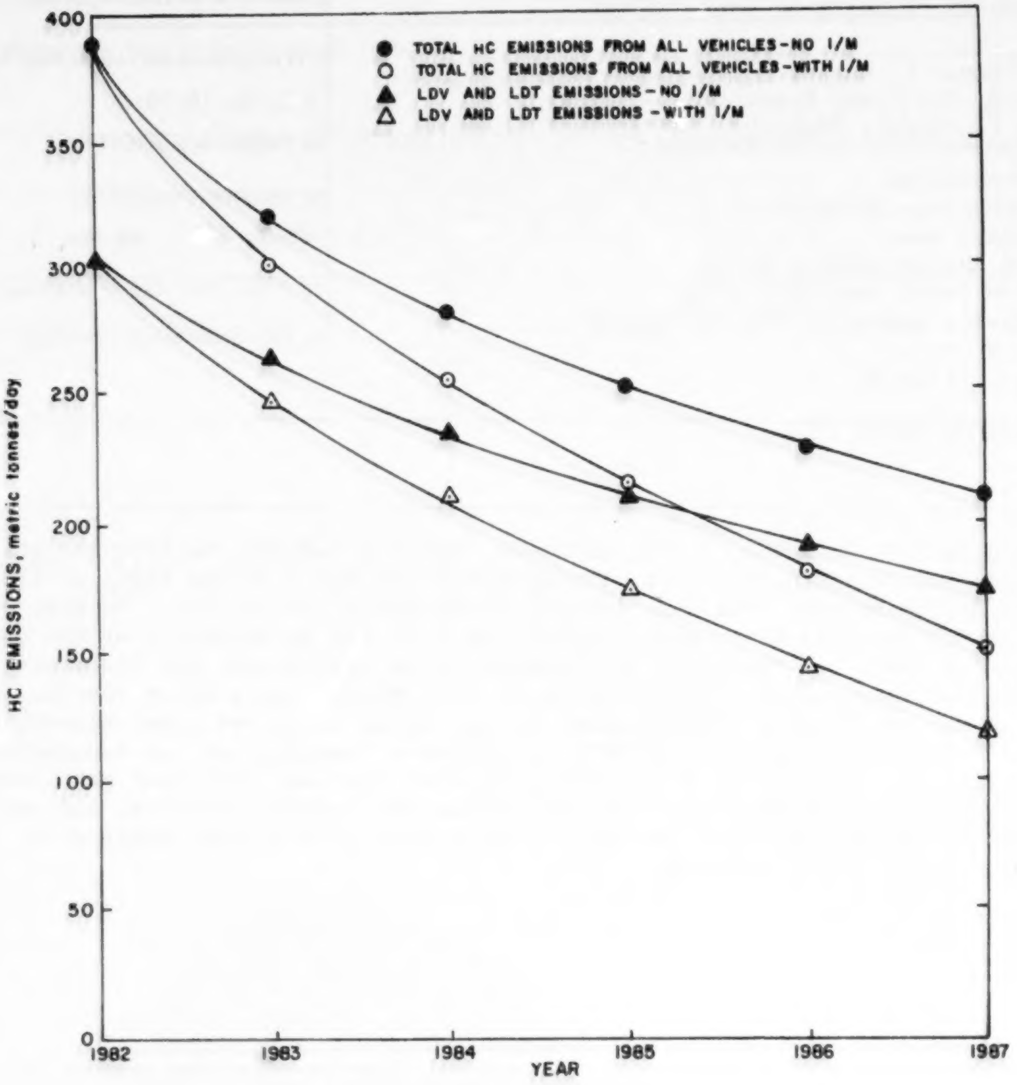

Figure 19. Ohio 18 urbanized counties, daily HC* emissions by year for LDV's and LDT's, and all vehicles with and without I/M - 1982 to 1987.

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*Nonmethane HC only.

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16. ABSTRACT

Recent data for the State of Ohio indicates that the National Ambient Air Quality Standards for CO and O_x will not be attained in all areas of the state by 1982, even if all reasonably available control technologies are applied. In view of this, it is likely that the state will request from U.S. EPA an extension of the compliance date beyond 1982. In order for this request to be considered, the state must, among other things, have adopted a firm schedule for implementing a motor vehicle inspection and maintenance (I/M) program in the highly urbanized nonattainment areas. In this connection, the State of Ohio is currently planning for the implementation of an I/M program. As part of this effort, detailed analyses have been performed of the costs, benefits, personnel requirements, direct and indirect impacts, and scheduling requirements associated with the particular program option being considered. This document reports these analyses.

17. KEY WORDS AND DOCUMENT ANALYSIS

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